The Nature of Science

UnderCurrents Volume 8 $6

Founded in 1988, *UnderCurrents* is an independent non-profit journal dedicated to the publication of critical work in the broad field of environmental studies. Produced by graduate students at the Faculty of Environmental Studies, York University, the journal publishes work by writers from a wide variety of experiential and academic backgrounds. The journal seeks to make explicit and contest the destructive political and cultural conceptions of natural and built environments that have precipitated the contemporary ecological crisis.

See the inside back cover for information on guidelines for submissions.

Orders and Editorial Correspondence:
UnderCurrents
c/o Faculty of Environmental Studies, York University
4700 Keele Street, North York, Ontario M3J 1P3 (Canada)
Phone: 416-736-5252 Fax: 416-736-5679
Internet: ES_Under@orion.yorku.ca

Single Copies:
$6 for individuals
Institutions, bookstores, and other commercial outlets in Canada, contact:
Doormouse Distribution
65 Metcalfe Street, Suite #6
Toronto, ON M4X 1R9

Phone: (416) 968-6890

Back Issues Available:
1995 The Politics of Natural Space
1994 Queer Nature
1993 Fragmenting Author-ity
1992 Situated Knowledge
1991 The Representation and Domination of Nature
1990 Nature, Culture, Self

UnderCurrents
ISSN 0843-7351, August 1996

Contents

General Editors: Laurie Miller, John Sandlos, Laura Wood

Editorial Committee: Onek Adyanga, Amy Block, Dagmar Boettcher, Elizabeth Bruckmann, Rose Cullis, Liana DiMarco, Shannon Hartigan, Rose Marie Kennedy, Mark Lutes, Laurie Miller, Eva Musso, John Sandlos, Derek Teevan, Janice Vogtle, Phillipa Wild, Laura Wood

Design/Production: Lesia Olexandra

Printer: King Print, Toronto, Ontario

Funding Support: The Graduate Environmental Studies Student Association, York University; Faculty of Environmental Studies, York University; Graduate Students' Association, York University; The Faculty of Graduate Studies, York University

Special Thanks: Laurie Miller, Joanne Nonnekes, Susan Jagminas, Catriona Sandilands

Editorial Essay

Thinking about "The *Nature* of Science" immediately invokes one to question the understanding of both terms. At first this statement engenders the essential character of science. The concept, though, is further troubling as the object of science, at least in principle, is nature. Hence, it becomes easy to see how our understandings of nature are bound up with science, while, simultaneously, our understandings of science are bound up in our notions of nature. Arguably, it is predominantly through science, at least since the Enlightenment, that we have come to know, name, represent and produce our natural world.

Bringing together the concepts of nature and science has provided this issue with fertile terrain to explore the multiple ways in which science is produced, interpreted and politicized in its relationship to "knowing" nature. As much scholarship in this area suggests, and as many of the authors herein maintain, science has been premised upon particular assumptions stemming from the Enlightenment, which has greatly influenced knowledge production. Science can no longer be thought of as the expression of an absolute truth, or linear, canonized and universal fact. Instead, it must be considered as a discourse, a product of social relations between subjects, and the objects of analysis. For if science is interpreted as neutral, it ignores and neglects the power/knowledge nexus that informs our perception of a given material object. There is, then, no innocent view of nature, nor can we uncritically accept the doctrine of objectivity. In this issue we seek to critically engage these scientific epistemologies.

Drawing on the Tatshenshini controversy, Anne Bell's provocative piece exposes the political nature of science, demonstrating that there are no value neutral "facts". Science, she argues, in the line of Donna Haraway, is a story telling practice and one which must be understood as the product of culture. Of particular interest is the manner in which the biological imperative demonstrates a commitment to objectivity, yet it is this same imperative that is drawn upon by both wilderness preservationists and the factions which oppose them. Her compelling portrait of the use of science in the Tatshenshini controversy demonstrates that science can be used in any number of ways, and, as Neil Evernden argues, that it has "no inherent bias towards nature preservation." Similarly, what we select to preserve is closely linked to our subjectivities, or to our attachment to a place. Bell thus argues that wilderness preservationists face a complexity of problems that include the social, political, economic, and ethical, for example, and calls for a challenge to the prerogatives of science and invokes alternative perspectives.

The epistemic underpinnings implicit in a commitment to objectivity is also found in the way science has been historically produced along gender lines. Amy Block's inquiry into the gendered construction of science traces first, second and third wave feminist critiques of science in relation to the "women question in science," and "the science question in feminism." Unearthing issues of phallogocentrism and power, she demonstrates that a simple joining of feminism and science does not escape the possibility of relying on essentialist discourses. Drawing on Elizabeth Fee and Donna Haraway, she argues that to escape the scientific canon and provide for responsible theorizing, we need an understanding that circumscribes a myriad of social relations, locations and contexts. Such a task would necessarily focus on the embodied nature of vision, where objectivity is understood as situated knowledge.

Recognition of the value laden nature of science is of central importance to Tres Fromme's piece on geographic information systems (GIS). Addressing the "darker side" of GIS technologies, he attempts to provide a critique of GIS in the context of power relations and metanarratives. He argues that no technological development is innocent, but is part of a larger matrix of multiple generative forces. Further, the insistence of GIS on standardization and universalization perpetuates a technological imperialism which could emerge as an aggressive colonizing force. Fromme poignantly argues that if we accept that culture and landscape exist as "polyglot matrices of perceptions, discourses and idiosyncratic responses," then the universalizing character of GIS has the potential to suppress multiplicity, at least to some degree.

Challenging the metanarrative of science is insisted upon in a number of pieces in this issue, as is the concern with fostering alternatives. Complexity theory, a theory which emerged from chaos theory, is one such position. Guy Letts insightfully argues that complexity theory poses interesting questions to the "modernist" view of the natural world as an ordered, mechanistic system. He suggests that complexity theory views systems, whether natural or cultural ones, as disordered, chaotic, fluid, interdependent and unpredictable. While criticisms of this perspective assert that complexity theory may be a simple refashioning of another metanarrative, Letts maintains that the important tenant of complexity lies in a new interpretation of the natural world which moves beyond oppositions, incorporating culture and society into a diverse web of interaction.

Recognition of closely interconnected forces frames Karl-Michael Nigge's essay on the role of boundary work. Writing on regulatory controversies, Nigge maps out the processes involved in regulatory decision making and demonstrates that science plays a limited substantive role as a result of "uncertainties", leaving much room for the strategic manipulation of the "gray zone". A prevalent theme throughout this volume, Nigge suggests that science is not independent of policy and cannot be separated from the social, political and economic realms in which policy decisions are made.

Pushing these themes to their logical limit, Laurie Miller questions whether the science of ecology is a useful foundation upon which to build an ethical basis for relating to the land. Indeed, subjecting moral *premises* to the "proof" mechanisms of ecological science reduces them to mere conclusions supported by a body of "objective" evidence. Hence, the ethical basis for our relationships to "the earth" depend on the body of evidence, or scientific story, to which one chooses to grant authority. Moral/ecological principles therefore become more subject to the rigors of the scientific peer review process, and are, as Miller suggests, an inadequate guide to "nature." The "land ethic" requires a deeper and more participatory source of authority to become truly meaningful.

Returning to Fromme's theme of the "darker side" of scientific production, Dean Bavington addresses the larger implications of the Human Genome Project (HGP). Scientists present nucleotide sequences as "pure" "truth" stemming from nature in much the same way as literal biblical interpretations were presented as stemming from God. In writing the book of life, scientists have assumed many of the roles of the priest, holding the interpretive power to create, define and describe that which they name – in this case life and nature. From the power of death to the power of life, to calls for genetic service, Bavington houses the HGP within a Foucauldian framework suggesting that it is now the gene (as opposed to the larger body) that is disciplined, thus producing "docile genes". In relation to late capitalism, the manipulation of genes has tremendous implications for pre-life and life management, and raises controversial questions relating to "purity", "difference", "nature", and the need to debunk the metaphor of life as a code.

This issue of UnderCurrents is attempting to deconstruct, and, perhaps, reinterpret, scientific knowledges in an attempt to unveil their particular, Western, relationships to the natural world. As many of the authors insist, science and its concomitant products, such as objectivity, knowledge, technique and technological artifacts, serve to mediate our multifarious conversations with nature. Recognizing, of course, that the articles presented herein do not exhaust the possible lines of inquiry, we do hope that, as a contested terrain, writing nature and science explores the multiplicity of forces that are part of the work of science, and provides space for further conversations.

Laura Wood and John Sandlos
for the UnderCurrents Editorial Collective

PHOTO: ADRIAN IVAKHIV

Science, Conservation and the Tatshenshini Controversy

By Anne Bell

One of the more celebrated conservation success stories in recent Canadian history was the protection of the British Columbian portion of the Tatshenshini watershed. Plans to mine a copper deposit at Windy Craggy Mountain, near one of the river's tributaries, were brought to an abrupt halt after the provincial government decided to set the area aside as a Class A Provincial Park in June, 1993. The decision was the result of intensive lobbying efforts on the part of groups and individuals who feared the impacts of mining on wildlife and on a place otherwise unmarred by roads, dams and industrial development.

Prior to the resolution of the issue, I spent a month on the Tatshenshini as part of an ecological research team sponsored by the Sierra Club of Canada. With a few companions, I explored the river's shoreline and tributaries in an effort to collect baseline data for use in the ongoing conservation campaign. Afterwards I sifted through all manner of articles, letters, pamphlets and reports on the Tatshenshini with the intent of examining and clarifying the terms of debate. It was the stories about nature, and the shape that they gave to people's understanding and experience of the river which interested me.

While my interpretation of these accounts is presented more fully elsewhere,[1] here I would like to focus specifically on the ways that science was brought to bear by stakeholders on both sides of the controversy. Just as conservationists pointed to the significant scientific values of the area, the mining faction argued that research into mining management could reduce or eliminate environmental risks. Common to both groups was their desire to have, or at least to appear to have, science on their side. As is often the case in conservation/ development disputes, evidence and arguments based in science were central to the decision-making process.

The Authority of Science

Given Western society's predilection for scientific accounts of reality, it should come as no surprise that conservation relies heavily upon the life sciences. Just as scientists generally have been "authorized to name what can count as nature for industrial peoples," (Haraway, 1988:79) so biologists and ecologists are called upon to identify, explain and solve conservation problems. They have a privileged role in defining the parameters of conservation debate, and in determining what ought to merit society's concern. This special charge has been allotted, as Donna Haraway explains, on the basis of science's unique claim to objectivity:

> *A scientist "names" nature in written, public documents, which are endowed with the special, institutionally enforced quality of being perceived as objective and applicable beyond the cultures of the people who wrote those documents (1988:79).*

Scientific accounts of nature are considered to be true, that is, to be accurate and unbiased depictions of what is *really* out there. They present *facts* which are explained in language that is "exclusively descriptive and avowedly neutral" (Evernden, 1992:85).[2] Their narrative dimension, veiled by an aesthetic of realism,[3] is rarely acknowledged. Biologists, says Haraway, "tend not to see themselves as interpreters but as discoverers moving from description to causal explanation" (1988:89).

We forget that science is the product of culture because we experience the knowledge that it produces as an objective reality. Mistaking the explanations for that which they describe, we lose sight of the fact, for example, that "biology is an analytical discourse, not the body itself" (1988:85). Or we speak of studying the "ecology" of an area, or of protecting an "ecosystem," as if as if the words corresponded to tangible things, rather than to theories and abstractions.

This objectivation of scientific narrative endows it with extraordinary power, for as a result it appears to merge with the world of nature (Berger and Luckmann, 1967:90). As Roland Barthes explains "the impression of human agency" is removed from such descriptions, so that we seem to be "dealing with indisputable facts" (quoted in Evernden, 1992:23). Science, consequently, is upheld as a universal authority, because its historical and cultural specificity is either denied or undetected by both its practitioners and their audiences.

Conservationists use science to better understand the issues at hand as well as to validate a desired version of events. "The environmental facts must be heard," we assert: "We must show the government that our criticisms are corroborated time and again by scientific research..." (TW, 1993). We cite the opinion of "experts" when describing the risks of development, just as we rely on biologists to describe the ecological significance of the places we are trying to protect.[4] When finances permit, we sponsor or undertake our own research to "get very solid scientific evidence" that will "prove once and for all" that areas, like the Tatshenshini, "must be preserved in perpetuity" (Ric Careless, quoted in Davison, 1992; and in Chard, 1992). Whenever possible, we also resort to science to discredit our opponents by showing their story to be out of touch with reality.[5]

They, in turn, employ similar tactics. Pointing to the extent and cost of studies which they have undertaken to protect the environment, they seek, through science, both to prevent and mitigate undesirable impacts,[6] and to vindicate their projects. They also aim to refute their detractors by demonstrating that technical solutions to environmental problems can be discovered and made available through scientific research: "legitimate concerns" (says Gerald Harper, former President and CEO of Geddes Resources) can be addressed (quoted in Reid, 1990). Meanwhile, the evidence presented by conservationists is dismissed as "romance," "misinformation," "conjecture," "myth" and a distortion of the "facts" (Haraway, 1988:577).[7]

The strategic importance of scientific argument in conservation/development disputes cannot be overstated. As stakeholders vie for public attention and control, their ability to impress decision-makers rides, more often than not, on the authority of science. Science, in other words, is inherently political, both in terms of the information that it provides and in terms of the way that information is subsequently deployed. Though it is widely regarded as neutral, science is in effect "a contestable text and a power field" (1988:577). It is a means of advocating and implementing social goals.[8]

Conservationists, like society at large, have invested heavily in science because it is believed to be an objective and therefore reliable guide to action (Evernden, 1985:88). It appears to free us from our emotional, impressionable and ultimately untrustworthy selves. This faith is expressed, for example, in Bill Devall and George Sessions's call for "more objective ecological criteria" in decision-making.

They point to the need "to move away from policy decisions based on subjective criteria such as 'public opinion' to more objective criteria based upon sound ecological principles" (Devall and Sessions, 1984:314). What these authors fail to acknowledge, however, is that the criteria and principles themselves are far from neutral. It is no mere coincidence, no simple matter of fact, for example, that ecology describes the world largely in terms of producers, consumers, productivity, competition, efficiency and (energy) exchange: according to Donald Worster, "in their most recent theoretical model ecologists have transformed nature into a reflection of the modern corporate, industrial system."[9] The economic metaphor reveals the driving resourcist assumptions of Western society.

"Science is a quintessentially human activity, not a mechanized, robotlike accumulation of objective information, leading by laws of logic to inescapable interpretation," asserts Stephen Jay Gould (1979:161). It is "always, in some measure, involved in matters of value and moral perception" concurs Worster (1985: xii). What these and other writers argue is that the facts of science are unavoidably coloured by the theoretical frameworks within which they are presented, and, further, that these frameworks are themselves socially constructed and therefore value-laden (Gould, 1979:161; Haraway, 1988:80).

"The detached eye of objective science is an ideological fiction, and a powerful one," says Haraway (1989:13). It is powerful primarily because we who live by it never think to question it. An integral part of our belief system, it passes for the most part uncontested, as does the world-view which it implies.

The Objectivity Imperative

In its official submission on the Windy Craggy proposal, the Sierra Club of Western Canada called for "an assessment of the ecological consequences of the project by an independent body of well recognized biologists" (SCWC, 1990). The request was indicative of the confidence with which most of us, I suspect, typically regard scientific evidence. It is presumed to be unbiased, and therefore indispensable to fair and impartial decision-making. Since the mandate of the decision-making body in this case, the provincial Commission on Resources and Environment, was to "neutrally administer" (CRE, 1992:16) land use allocation throughout British Columbia, the testimony of biologists, ecologists and other scientists was bound to play a key role. In its efforts to provide "information in which all parties have confidence," to "build agreement based on objective criteria," and to avoid disagreements over the "credibility and neutrality of information," (ibid, 20, 21, 29) the commission had little choice but to look to the authority of science to consolidate its own. In turn, the credibility of the decision-making process was linked to that of the Provincial Government which was likewise "committed to a careful, reasoned approach to difficult land use and resource development issues, based as far as possible on an objective evaluation of factual information as well as stakeholder views" (BC, 1992). Legitimacy and power at all levels rested on a convincing display of neutrality.

In order to be heard, Tatshenshini supporters had to demonstrate a similar commitment to objectivity. In many respects, this parameter was helpful, for it provided a platform from which to mount a persuasive yet seemingly disinterested defence. It allowed us to argue, for instance, in the name of a "biological imperative" which dictated that large tracts of wilderness had to be protected if biodiversity were to be preserved (SCWC, 1990). We were able to step outside a strictly utilitarian paradigm and to advocate impartially on behalf of species, populations, ecosystems, landforms, water quality, habitats, migration corridors, and so on. Of equal tactical importance was the fact that we could plead in the interest of science itself.

Ric Careless, a founding member and executive director of Tatshenshini Wild, used precisely this approach when discussing the issue in an interview with the *Whitehorse Star* (Davison, 1992).[10] Distancing himself from the more self-interested wilderness recreation arguments, he redefined the stakes in terms of their scientific significance:

> *When we first got involved in this issue, we thought we were dealing with the protection of a spectacular river, spectacular mountains and big ice fields [...] what we've come to realize is that the wildlife and biodiversity values in there are exceptional.*

The Tatshenshini was portrayed as a "major wildlife corridor" through the St. Elias Mountains, which provided critical denning habitat for grizzlies. It would be an ideal site for a permanent research station, maintained Careless, and regardless of the land use dispute, represented a golden opportunity for science:

> *Even if we didn't have a wilderness proposal, even if we didn't have a Geddes proposal, this area would still be top-rank to find out how this planet of ours operates [...] there is hardly any other opportunity to study an area that is so intact with the diversity of biological systems we have in there.*

The underlying thrust to his argument was that society could not allow this unique place, nor this rare chance to further human knowledge to be jeopardized.

Implications of Objectivity

The story of objective science, which has dominated scientific thought and practice since the Renaissance, is based on the Baconian understanding that reality is made up of physical objects which behave and interact in accordance with natural law.[11] In this material world, humanity's place is that of the knowing subject whose role it is to measure, manipulate and master the "mass of miscellaneous stuff" (Worster, 1985: xi) known as nature. Through the application of reason and technique, we describe, quantify, then commodify and exploit a world devoid of agency and spirit (Worster, 1985: xi).[12] In our quest for control we adopt a posture of detachment and dominance over the object - nature - which we meticulously "scour" of projected normative qualities (value, meaning, mood) (Evernden, 1992:39).

Inherent in this world-view is the absolute separation of human from nonhuman nature, of subject from object. As Charles Bergman explains, "knowing animals objectively" means "distance from and power over nature" (1990:228).[13] Indeed it is this unbreachable, institutionalized gulf between *us* and *them* which gives science its credibility. According to Evernden:

> *To be objective in this sense, is to be uninvolved – to be the neutral observer who is believed to be the most reliable guide to action. Since by this understanding the objective person is not personally committed, he has no vested interest in that which he views. Neither does he have any obligation towards it (1985:88).*

Sandra Harding likewise argues that scientific authority is based on the effective policing of the boundary between rationality and social commitment (1986:124). It relies on the assumption that feeling and ethical judgement can be suspended by describing the living world solely in terms of its quantifiable, material manifestations.

PHOTO: ANNE BELL

This perspective is particularly well-suited to the designs of industry, for it facilitates an imperialistic stance towards nature, where the desired end is not so much knowledge as control. Barry Lopez makes the following comment, for instance, regarding scientific/industrial exploration in the Arctic: "Whenever we seek to take swift and efficient possession of places completely new to us, places we neither own nor understand, our first and often only assessment is a scientific one" (Lopez, 1987:204).

Not surprisingly, proponents of the Windy Craggy project were hoping to advance their cause by restricting the scope of environmental debate. Anxious to narrow the focus of discussion, the mine developers, Geddes Resources, criticized government review comments for being "too broad-based to be realistically answered" and for not "sufficiently defin[ing] the scope of the work" to be done. Of special concern was the extent of wildlife studies required, and whether these should not be limited to direct mine impacts (Hendrick, 1991). It was in the company's interest, of course, to limit debate to matters of science and technology, and in so doing to marginalize or exclude the emotional and ethical arguments which might sway opinion towards the preservation option. It was for this reason, I suspect, that Geddes announced "a series of open house events at which scientists [were to] be available to discuss some major areas of interest" (Morphet, 1990). These included acid mine drainage, water quality, hydrology and glaciology, all of which fit safely within the parameters of "objective" science.

Such technical issues dominated the official review of the mine and as a result, Tatshenshini advocates devoted considerable time and effort to developing expertise in each. For strategic reasons, it was deemed necessary to enter into the prevailing mindset and to be able to converse on those terms. In this, science served as both a tool and ally, furnishing the data, the objective outlook and the requisite air of authority. Proceeding on the assumption that scientific evidence would favour the preservation option, conservationists also insisted that further studies be conducted in virtually all aspects of the mine proposal, and that it be subjected to rigorous environmental reviews in both Canada and the United States.[14]

Given the final outcome of the dispute, our confidence in this regard seems to have been justified. Yet as Evernden, David Ehrenfeld and others have shown, science can be used in any number of ways: it has no inherent bias towards nature preservation (1992:9; 1981:199). On the contrary, science is committed to progress and problem-solving, which is the antithesis, really, of the "deeply conservative feeling of distrust of irreversible change" that motivates the preservationist (ibid.,178). Science favours a more "optimistic" perspective, one based on the belief that, with time and ingenuity, humans can come to a "fully accurate understanding of nature," and thus master all obstacles.[15]

The reluctance of decision-makers to reject outright the Windy Craggy proposal, despite almost unanimous "expert" agreement about its serious technical flaws,[16] testified to society's unwavering faith in the capacity of science to overcome all difficulties. Additional research into mining and mine impact management was urged by business and government alike in the hope that it might be possible to "reduce or eliminate inherent risks" (CRE, 1993:101-105). In that event, CORE could conceivably have recommended the mining option since it would have satisfied most, if not all of its land use objectives. Specifically, environmental impacts could, theoretically, have been "minimized" while market-related economic benefits were "maximized."

Tatshenshini advocates were reluctant to even contemplate such a possibility, however, since outright preservation was the goal. Most of us seemed to agree that if the mine were developed, wildlife impacts, habitat damage, spills of toxic substances and other accidents would occur. We pointed to the "unproven" technologies, the "experimental" methods and the "serious risks" that Windy Craggy entailed, and called for "prudence", "adequate assurance" and "absolute guarantees."[17] It is ironic though, that even as we asked for proof and further research, we denied that this could ever make the mine acceptable. "It's impossible to have a huge industrial complex in the middle of a wilderness - the two are not compatible," stated Haines lobbyist Peter Enticknap (quoted in Ripley, 1991). You cannot be "half pregnant," concurred Careless (quoted in Hendrick, 1991). Perhaps then, we were being somewhat less than consistent in our demands for additional studies of the Windy Craggy proposal and of the Tatshenshini area. If it were true that we had no intention of accepting a compromise, then it seems we were resorting to a subterfuge.

The objective science subterfuge proved undeniably useful. Its metaphors and explanatory frameworks were well-suited to the institutional context within which the matter was debated. In retrospect, however, as a key argument in our rationale for conservation, it strikes me as both confusing and disturbing. For one thing, it implied that we shared with Geddes, CORE and other stakeholders a common understanding of what constituted *conservation*: in this case, the prevention of acid mine drainage and the mitigation of road impacts on wildlife, particularly fish and game. The question then is whether our understanding did indeed fit this neat and narrow interpretation. Would we have been satisfied with a "clean operation," an "invisible" access road, and "measures to protect and assist the wildlife populations," (Harper, quoted in Reid, 1990) if this had been possible?

On the contrary, it seems that few if any of us equated protection of the Tatshenshini with feats of engineering. We were moved to defend the whole, not just isolated parts or percentages. We feared that the mine would "desecrate", "scar" and "violate" a "temple of rock and ice," a "world treasure," a "magical" place of "untouched beauty and boundless nobility," and the fervour in our language testified to the moral and emotional dimension of our commitment.[18] The distance suggested by an objective approach to the issue belied the great importance that we attached to the meaning of the place, and to our relationships with it. Evernden writes that environmentalists are defending cosmos, not scenery, and I believe that this was the story of most Tatshenshini advocates (1985:124).

Science and Partial Perspective

The role of science in conservation is fraught with ambiguity. Reflecting on his involvement in a biological study which required the killing and dissecting of seals, Lopez discusses his feelings of ambivalence:

> *I understood some of the extenuating circumstances, and that, ironically, environmentalists would have these data to stand on in a court of law. But I had no finished answer. I stood uncomfortable, like so many, in the middle of the question (Lopez, 1989:161).*

Science cannot possibly capture the complexity (social, ethical, spiritual) of the problems we face, nor even necessarily those aspects we regard as most important,[19] yet it commands staunch and uncritical allegiance. The scientific perspective, like all human perspectives, is partial, as Lopez suggests in the following:

> *It is hard to say exactly what any animal is doing. It is impossible to know when or where an event in an animal's life begins or ends. And our human senses confine us to realms that may contain only a small part of the information produced in an event (1989:201).*

Conservationists seem most reluctant to admit or address the limitations of scientific knowledge. Perhaps we are afraid to challenge its authority for fear of jeopardizing our own credibility.

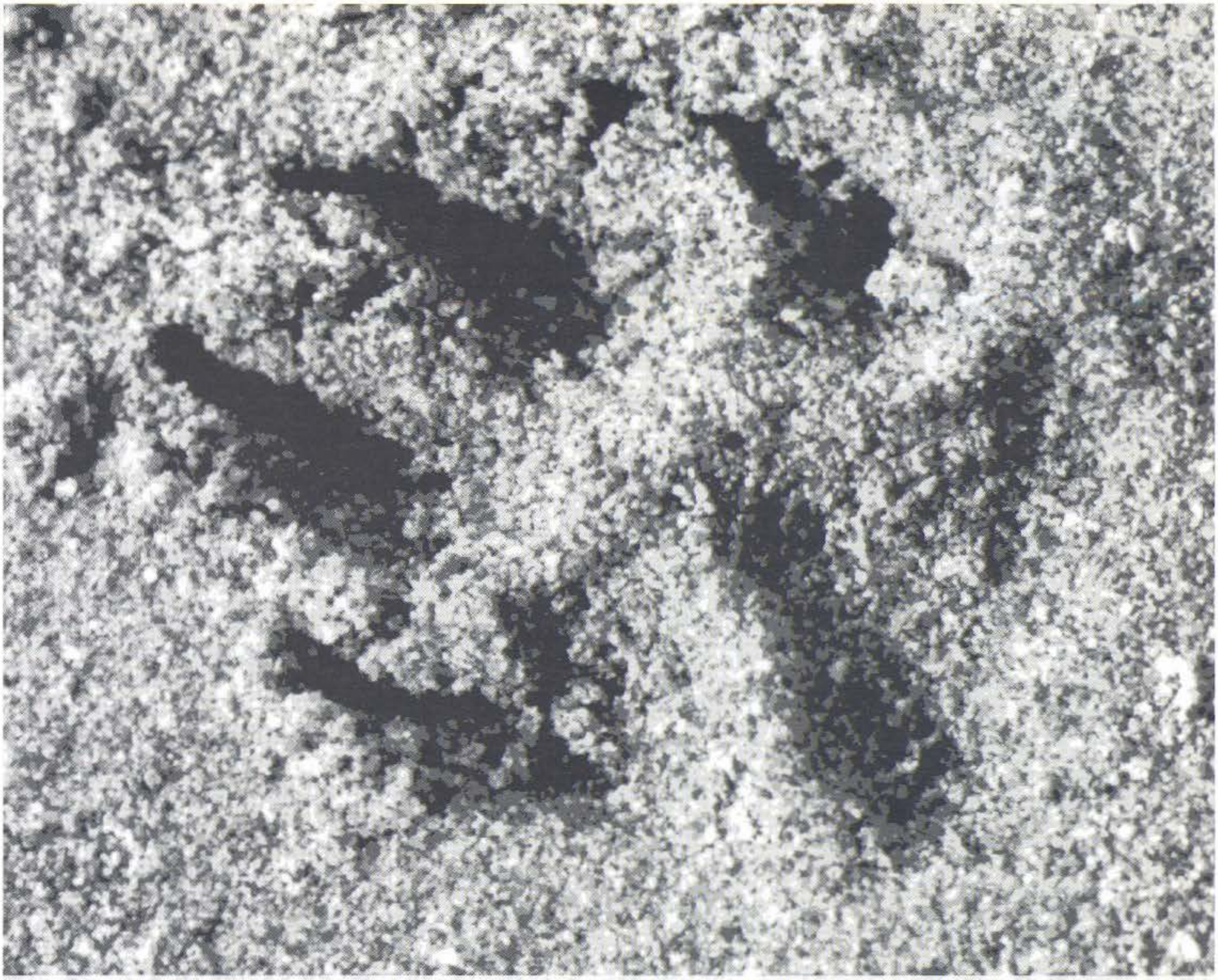


PHOTO: ANNE BELL, WOLF PRINT

Perhaps, as products of our culture, we simply fail to see that science is indeed a "story-telling practice" (Haraway, 1989:4). Whatever the reason, the result of our unquestioning compliance has been limited understanding and the concentration of decision-making power in the hands of an "expert" elite.

Commenting on the cultural and historical specificity of primatology, Haraway remarks that the scientific way of looking at monkeys and apes has been "inconceivable to most men and women" (1988:78). Indeed, scientific accounts have been given special privilege at the expense of the vast majority of humankind whose testimony and experience are relegated to the periphery. In his critique of "radical" American environmentalism and wilderness preservation," Ramachandra Guha relates, for example, the anecdote of an American biologist in India who declared that "only biologists have the competence to decide how the tropical landscape should be used" (1989:75).

With respect to research that needed to be undertaken on the Tatshenshini, consultant Juri Peepre discussed the privilege and limitations of the Western scientific perspective. Basing his comments on the work of J.A. Cruikshank, he explained that science is seen, mistakenly, to be a "superior model of explanation," and that the oral tradition of aboriginal cultures is considered useful only if it "confirms views put forward by scientists." He warned that scientists were ill-equipped to understand traditional aboriginal knowledge because of their narrow epistemological framework, and concluded that "our usual scientific approach to inventorying wilderness resources is not good enough" (1992:93).[20]

Critical views, like those of Peepre, are becoming increasingly familiar in conservation circles today, and yet how we might move, as he recommends, beyond narrowly scientific approaches to accommodate other knowledges remains unclear. Alternative perspectives continue to be marginalized, in part because of societal expectations and institutional givens, but also because conservationists are willing to fashion their efforts to suit accepted storylines. Such conformity is understandable. Being practical, reasonable and efficient means amassing and making use of the facts and figures that will win the day, including those provided by science. As a result, however, dominant understandings assume a self-fulfilling potency, their short-comings and questionable implications neither acknowledged nor dealt with.

While I do not wish to suggest that conservationists should or could afford to do without science, I do think we might call the bluff of those who pretend to objective, value-neutral information and argument. The point of doing so would not be to dismiss science, but to challenge its prerogative. As Evernden suggests, we must look for "a new conversation, one in which the 'voices' permitted are not limited to those of practical activity and science" (1992:102). Despite the great range of human inquiry, writes Lopez, no one thinks to call in painters, musicians, novelists, historians, philosophers or theologians to comment on or respond to the issues which confront us (1989:146; 1987:24). It is time for conservationists to contest this imbalance and the restrictions that it places on environmental debate.

Notes

1 Anne Bell, *Conservation Stories: Protecting the Tatshenshini*, (Unpublished Major Paper submitted to the Faculty of Environmental Studies, York University, 1993).

2 See also Morris Berman regarding the split between fact and value that characterizes the modern age, in *The Reenchantment of the World*, (New York: Bantam, third printing, 1989) 4.

3 Regarding the aesthetic of realism, see Donna Haraway, *Primate Visions: Gender, Race and Nature in the World of Modern Science*. (New York: Routeledge, 1989) 4.

4 See, for example, Canadian Parks and Wilderness Society, fund-raising letter, (Fall 1992); Western Canada Wilderness Committee, "Save the Tatshenshini...The Wildest river in North America," 11:2 (Vancouver: Spring 1991); World Wildlife Fund, "Endangered Spaces" (Toronto: Summer 1991).

5 See, for example, the Sockeye Society of Haines Alaska, memo to Michael Dunn, Environment Canada, and *Response: Windy Craggy Project: Revised Mine Plan: Stage 1, Environmental and Socio-Economic Impact Assessment*, (Haines, February 1991) 4,6,16.

6 See "B.C. mine official denies claim project a threat to wilderness," *The Vancouver Sun* (03/22/90); Mark Hume, "River of conflict," *The Vancouver Sun* (04/28/90); Geddes Resources Limited, "Windy Craggy Project Public Information Meetings," report prepared for the Mine Development Steering Committee, Government of British Columbia, (Vancouver: May 1990) 63; and "Ore in abundance, Geddes says", *Chilkat Valley News* (10/04/90).

7 See, for example, B.C. Environmental Information Institute, "Member's Bulletin," (Vancouver: 12/13/91) 2; John Schnabel, "Benefits abound if mining done in environmentally sound manner," *The Anchorage Times*, (03/12/92); Harper, "Presentation on Windy Craggy", (Whitehorse: 10/12/89); and "B.C. mine official denies claim project a threat to wilderness," *The Vancouver Sun* (03/22/90).

8 See Evernden (1992) 15.

9 See Donald Worster, *Nature's Economy: A History of Ecological Ideas*, (Cambridge: Cambridge U.P., 1985) 292-294, 311-315; see also Berman, 37.

10 Careless uses the same approach in Chard (07/08/92) and in the Tatshenshini Wild fund-raising letter (June 1992).

11 See Berman, 2, 15-17 as well as Worster's discussion of the "imperial" tradition in ecology; See also Evernden (1992) 99.

12 See Haraway, "Situated Knowledges", 592 regarding the denial of agency in the analytic tradition; and Berman regarding "the mechanical philosophy", 2.

13 See also Berman, 15-21.

14 See Mark Hume, "River of conflict," *The Vancouver Sun*, (04/28/90); Glenn Bohn, "U.S. groups join fight for B.C. river," *The Vancouver Sun*, (10/29/91); and literature from such conservation groups as the Canadian Parks and Wilderness Society, Lynn Canal Conservation Inc., Western Canada Wilderness Committee, World Wildlife Fund Canada and Tatshenshini Wild.

15 See Ehrenfeld regarding optomistic assumptions; Haraway regarding "commitment to progress" (1989) 4; and Berman regarding the myth of progress, 75.

16 See, for example, J.C. Errington and F.J. Hall, Ministry of Energy, Mines and Petroleum Resources, Memo to Norman Ringstad, Mine Development Steering Committee (03/26/91).

17 See the submissions of the National Audubon Society (Memo to Norman Ringstad, Mine Development Steering Committee, Washington: 12/01/91), the Sierra Club of Western Canada, the Sockeye Society of Haines Alaska, the World Wildlife Fund, Western Canada Wilderness Committee, and Tatshenshini Wild (press release, "Revised mega mine plan poses even greater environmental threat to world class Tatshenshini wilderness" (01/28/91).

18 What understandings of conservation do these expressions evoke? See Bell regarding preservationist and wilderness stories, 39-66, 86-100.

19 See Jack Turner regarding conservation biology, "The quality of wildness: preservation, control, and freedom," in Dacid Clarke Burks, ed., *The Place of the Wild*, (Washington: Island Press, 1994).

20 Peepre quotes J.A. Cruikshank's "Legend and Landscape: Convergence of Oral and Scientific Traditions in the Yukon Territory," from Arctic Anthropology, xviii-2, 1981.

References

Bergman, Charles. (1990) Wild Echoes: Encounters with the most endangered animals in North America. Toronto: McGraw-Hill Publishing Company.

Chard, Paul. (1992) "Scientists hit the Tat to study wildlife," In Yukon News, July 08.

Commission on Resources and Environment (CRE). (1992) Report on a Land Use Strategy for British Columbia. Victoria: August.

Commission On Resources and Environment (CRE). (1993) Interim Report on Tatshenshini/Alsek Land Use. Victoria: January.

Davison, Sarah. (1992) "Group intensifies river basin work," In The Whitehorse Star, July 23.

Devall, B. and G. Sessions. (1984) "The Development of Natural Resources and the Integrity of Nature," In Environmental Ethics, Winter.

Ehrenfeld, David. (1981) The Arrogance of Humanism. Oxford: Oxford University Press.

Evernden, Neil. (1985) The Natural Alien. Toronto: University of Toronto Press.

______. (1992) The Social Creation of Nature. Baltimore: Johns Hopkins University Press.

Gould, Stephen Jay. (1979) Ever Since Darwin: Reflections in Natural History. New York: Norton Paperback.

Guha, Ramachandra. "Radical American environmentalism and wilderness preservation: a Third World critique," In Environmental Ethics, 11,1, Spring.

Haraway, Donna. (1988) "Primatology is Politics by Other Means," in Ruth Bleier ed., Feminist Approaches to Science. New York: Pergamon Press.

______. (1988) "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," In Feminist Studies, 14, 3: 577.

Harding, Sandra. (1986) The Science Question in Feminism. Ithaca: Cornell University Press.

Hendrick, Bonnie. (1991) "Politicians enter Windy Craggy debate," In Chilkat Valley News, July 18.

______. (1991) "Multi-use study to precede further Windy Craggy review," In Chilkat Valley News, Sept. 19.

Lopez, Barry. (1987) Arctic Dreams: Imagination and Desire in a Northern Landscape. Toronto: Bantam Books.

______. (1989) Crossing Open Ground. New York: Random House Inc.

Tatshenshini Wild (TW). (1993) Fund-raising letter. Vancouver: Winter.

Morphet, Tom. (1990) "Geddes develops port plan," In Chilkat Valley News, Nov. 15.

Peepre, J.S. and Associates. (1992) Tatshenshini-Alsek Region Wilderness Study. Victoria.

Province of British Columbia (BC). (1992) "Discussion paper regarding the Tatshenshini-Alsek/ Windy Craggy Issue, prepared for a meeting with stakeholders" In Juneau, Aug. 04.

Reid, Campbell. (1990) "Wild rivers versus mountain of copper," In The Mercury, Hobart, Tasmania, May 05.

Ripley, Kate. (1991) "Canada starts new review of Windy Craggy Mine," In Juneau Empire, Sept. 24.

Sierra Club of Western Canada (SCWC). (1990) Letter to Ray Crook, Mine Development Steering Committee, and "Comments on Geddes Resources Stage 1 Environmental and Socio-economic Impact Assessment on its Windy Craggy Project," Apr. 10.

Worster, Donald. (1985). Nature's Economy: A History of Ecological Ideas. Cambridge: Cambridge U.P.

Anne Bell is a graduate student in the Faculty of Environmental Studies at York University. She gratefully acknowledges the financial support of the Northern Scientific Training Program and the Social Sciences and Humanities Research Council of Canada.

Castle Pass, 8000 ft

By Joanna Beyers

Mid-afternoon of the last day
waiting for the first stir of the helicopter
hammer in hand and alone
a clearing deep in the focussed moment.

Nearby Paradise Creek drains
last season's snow; marmots sound
their one-toned alarm.
Then the low stammer of the Bell Jet-
Ranger, uncertainly heard,
ahead of the dark shape that slowly
grows against the mountains and which we approach
later, from high ground, displeasing the pilot
("you could lose your head like that").

This morning a loon sang on Tyaughton Lake
near the dock on which the helicopter rests
before the blades whirl and we lift off
the water beneath us a momentary flower.

Joanna Beyers is a Ph.D. candidate in the Faculty of Environmental Studies at York University. Her work appears in many literary magazines and she has published a volume of poetry entitled "Sandbar Islands" (Caitlin, 1988).

PHOTO: JERRY VALEN DEMARCO

The Gendered Construction of Science

By Amy Block

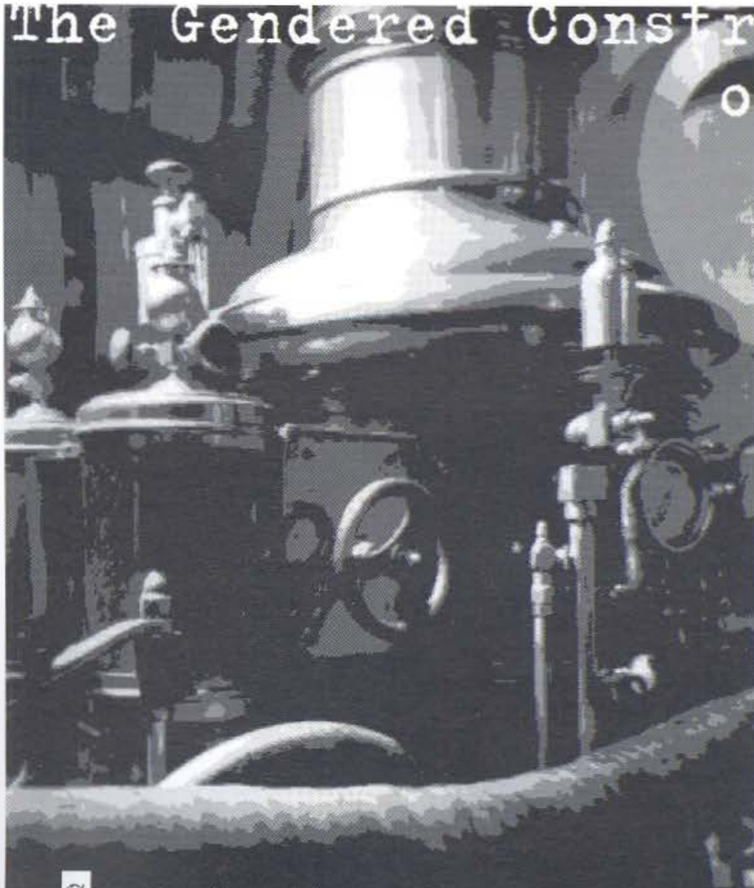


PHOTO: GUY LETTS

Since the advent of the scientific revolution, science has been purported to transcend the realm of the social. In the Western world, this is a luxury only science seems to enjoy. Indeed, our tolerance seems to be built into the very foundations of the scientific methodology itself: scientific methods are selected such that all social values are excluded from inquiry. The thinking follows that, when used properly, scientific method generates observations that are "objective" and results that are truly "value-free". In light of the meaning that science imparts, forging a connection between gender and science presents itself as an immediate paradox; to unearth the issues which surround this notion inevitably entails a kind of intellectual revolution. For feminist critiques of science, the task at hand is not an easy one. Sandra Harding observes that in modern cultures "neither God nor tradition is privileged with the same credibility as scientific rationality" (1986:32).

Despite the dominant culture's insistence on an essential scientific "objectivity," feminist critiques of science persist. Using numerous theoretical accounts, supplemented with my own experiences as a biology student, I will attempt to trace the evolution of these critiques. I will identify four waves of investigation that characterize the pursuit: beginning with the retrospective approach, feminist philosophers and historians of science take on the task of accounting for and recounting women's experiences in science. These initial studies comprise the first wave of feminist critique. Delving into more radical territory, the second feminist agenda focuses on addressing the implicit androcentric bias in the experimental design and interpretation of results. These two approaches are limited in that they fail to shake out issues of gender, power and domination, embedded in the very foundations of scientific ideology. Attempting to account for the conceptual and practical linking of objectivity, autonomy and masculinity that underlies scientific methodology, the third wave of feminist critique involves Evelyn Fox Keller's invocation of object relations theory. Elizabeth Fee and Donna Haraway, fourth-wave feminist critics, reject this account, for it fails to resolve issues of power and phallogocentrism inherent in the scientific conception of "objectivity". Finally, Haraway destabalizes objectivity, freeing it from its universalizing effect. On the one hand, the consequences of Haraway's argument change the face of science. On the other hand, her argument changes the face of feminism. By outlining the shift in focus from "the women question in science" to the "science question in feminism" (Harding, 1986), I will show how Haraway's understanding of objectivity intervenes in the struggles of contemporary feminism. Objectivity in Haraway's terms will provide the epistemological foundation for feminist politics that refuses to rely on a homogenized, exculsionary subject: woman.

In Cell and Molecular Biology, my introductory biology textbook, the achievements of male scientists are numerous, filling the greater content of the text. Yet, mention of the female scientist is sparse: in the course of the text, the achievements of only two female scientists are described. Sceptically, I asked: "Where are all the women in science?" Scanning the McGill 1993 calendar, I discovered that perhaps this is not a question of the past: of 48 faculty members, only 3 positions were occupied by women. This kind of inquiry characterizes the "woman question in science" (Harding, 1986) which motivates feminism's initial pursuit. In mapping the field of gender and science, Schiebinger (1987) identifies two primary conceptual approaches. The first seeks to recover the unknown woman scientist, "to brush off the dust of obscurity from those women scientists whose scientific contributions have been neglected by mainstream historians of science" (Schiebinger, 1987:9). The second approach compliments the first by analyzing the history of women's participation in the institution of science, focusing on the history of women's limited access to the means of a scientific profession.

Harding discusses the results of these initial studies. Historical studies and bibliographies of contemporary scientists bring to attention what she names "women worthies" (Harding, 1991:22). Those women whose contributions to the field have been ignored and devalued in the mainstream scientific canon. In addition, Harding directs attention to the less public, less official, less visible and less dramatic aspects of science in order to gain the full scope of women's participation. Next, she describes both the structural and informal barriers that these initial feminist critiques of science unveil. From scientific education to lab appointments, from journal publications to membership in scientific societies, structural barriers existed that denied women acces to the scientific enterprise. Finally, she describes the feminist sociological and pyschological studies that uncovered implicit, informal barriers . The mechanisms of the informal discrimination include the devaluation of women's work, the exclusion of women from men's informal networks and the obstacles women meet trying to find reliable mentors. Thus, the first wave of feminist critique reveals that overt and covert sexism exists in all aspects of the scientific enterprise.

These initial studies point to surface problems in and around the institution of science. Clearly, steps must be taken to ensure equity; equity in terms of the scientific education of little girls and boys and equity in the working world of male and female practitioners of science. These claims are consistent with those the liberal feminist movement has attempted to hurdle within all social institutions. The liberal feminist position suggests that with equity legislation in place, women will enter the scientific enterprise unhindered. But Keller demands to know what women's participation will mean to science (1982:234). According to the liberal view, science will in no way be affected by the presence or absence of women. However, women's participation in "science as usual" (Schiebinger, 1987:9) is problematic in and of itself. Harding asks: "Should women want to become just like men in science?" (1991:33). Ultimately, Keller, Harding, Fee, and Schiebinger call for a more radical critique of science. Schiebinger urges that the feminist movement take it's privileged perspective seriously: "From their position as outsiders, woman (like other 'outsiders', ethnic minorities and non-elites) have at this historical moment an opportunity to make a difference" (1987: 9).

More radical criticism follows the liberal feminist approach to the "women question in science" (Harding, 1986). Keller documents how the second wave of feminist critiques of science argue that the predominance of men in science has led to a bias in the choice and definitions of problems with which scientists have concerned themselves. For example, contraception has been given an unwarranted abundance of scientific attention. Furthermore, the attention it has received has been directed primarily on risky contraceptive techniques to be used by women (Keller, 1982:234). This second wave of feminist critique also reveals a bias in the actual design and interpretation of scientific experiments. Virtually all animal-learning research performed on rats uses only the male cohorts of the species. It is argued that the female rat's four day cycle complicates experiment procedures. However, the underlying assumption is that the male rat adequately represents the entire species. If research permits, the male rat will eventually come to represent the entire human species as well. The tendency for scientific explanation to rely on a male standard persists, predominantly in behavior and socially oriented sciences (Keller, 1982:235). For example, Southin's explanation of gametogenesis reads, "in mammalian females, instead of four functional products of meiosis [as in mammalian males], there is usually only one" (Southin, 1991:74). Contrasting female development to male development, using words like "instead" and "only" highlight an implicit standard set by the male example.

The studies outlined above point to an actual bias in the design and interpretation of scientific experiments. The second wave of feminist critique explains this tendency by alluding to the historical absence of women from mainstream science. According to this reasoning, women's valued presence in science will alleviate the aforementioned tensions. With equal participation of men and women in science, the bias, in effect, will cancel itself out. Again, the net solution implies that the need is not for science to accommodate women, but for women to accommodate science. Yet, a closer look at these studies reveals a more radical concern than this explanation offers. These studies imply that science's fortified tool, the key to its "objectivity" – the valorized "scientific method", can actually produce biased and obscured results. Clearly, it is not enough, therefore, to assert that by simply increasing the number of women in science, androcentrism will be obliterated. Scientific methodology, by definition, meant an ultimate obliteration of androcentrism, and Eurocentrism and classism, and so on. However, the explanation offered by this wave of feminist critique leaves "scientific methodology" stabily established, and the essential "objectivity" remains unshaken.

On the quest for a more lucrative account of women's absence from science, and in an attempt to penetrate the notion of scientific objectivity, Keller's ground-breaking work marks the third wave of the feminist critique of science. Essentially, Keller contests the postulate that women in science means "science as usual" (Schiebinger,

PHOTO: JERRY VALEN DEMARCO, FATHOM FIVE NATIONAL MARINE PARK

1987:9). Her biographical account of plant geneticist, Barbara McClintock, documents scientific progress achieved not through detached objectivity, but rather through 'feeling for the organism' (Keller, 1983). This was a technique unheard of (and mocked at) by McClintock's male contemporaries. Keller argues then, that clearly it is science that must accommodate women. Her analysis suggests the means by which this can be achieved. Beginning with an explanation of how scientific language is embedded in culturally laden metaphor, she demonstrates how 'objectivity' inherent in science comes to be seen simultaneously as both disembodied and male. Using object relations theory, Keller then argues that individual gender development produces men suited for science and women alienated from the pursuit. Ultimately, she suggests a revised notion of objectivity, providing the basis for a kind of androgynous science that balances both male and female "ways of knowing".

Keller's primary concern with science is that it replaces ordinary language with a technical discourse purported to be cleansed of the ambiguity and values that burden its predecessor. Scientists insist, "let data speak for themselves". The problem, Keller argues, is that data never do speak for themselves. In science, and elsewhere, interpretation requires the sharing of a common language. In that way, science is embedded in a community of common practices and shared conceptions. She argues that sharing a language means sharing an entire conceptual universe. This means that the identified scientist must not only know the right names to call things, but also the right syntax to pose questions and assert conclusions (Keller, 1992:27). Thus, participating in science involves "sharing a more or less agreed-upon understanding of what questions are legitimate to ask, and what can be accepted as a meaningful answer" (Keller, 1991:28).

Keller continues to demonstrate that the seemingly pure and technical discourse of science depends heavily on metaphor, ambiguity and the instability of meaning. She asserts that the language and metaphors of the scientific revolution were clear: sexuality was the metaphor for the mediation between mind and nature. While mind was posited in the realm of 'male', nature was posited in the realm of 'female'. Under this paradigm, the pursuit of scientific knowledge, or access to nature, is constituted as an act of aggression. Fee adequately summarizes this notion, describing how scientific metaphor suggests that "a passive nature had to be interrogated, unclothed, penetrated, and compelled by man to reveal 'her secrets'" (1986:44). Furthermore, the laws of nature which science seeks to unveil are rooted in metaphor which is historically conceptualized as imposed from above and obeyed from below. Again and again, in a multitude of disciplines and languages, "we find the familiar dualism's of mind and body, culture and nature, rationality and emotionality, activity and passivity, objectivity, subjectivity, male and female" (Fee, 1986:44). Suddenly, the language of science is seen to carry the imprints of culture. Women's absence from science is perhaps better understood as an "outsideness" from science, rooted in scientific ideology itself. While males assume the role of arbitrators of science (i.e., the subjects of science), women inevitably represent their field of interest (i.e., the objects of science).

Keller's discussion of language and metaphor explores new territory which had previously eluded feminist critique. First, and perhaps most radically, the notion of "science in a vacuum" and its "value-free" observations, collapses with the elucidation of an all encompassing language-culture effect. Keller asserts, first, that in a patriarchal society, science is 'male', in its fundamental ideology. Second, she argues that explanations for androcentrism in science that rely on the historical absence of women are simply inadequate as language and culture are postulated to be factors in this ideology. Along these lines, Keller's argument may lay the foundation for understanding what my organismal biology professor was hinting at when he explained to me that while my answer was not incorrect per se I "should learn to write more like Hemingway."

Keller's argument points to the implications of the Hemingway remark. What does it mean to "write more like Hemingway"? Abrams' A Glossary of Literary Terms describes Hemingway's work as the epitome of paratactic writing. Paratactic writing style is defined as "one in which the members within a sentence or else a sequence of sentences are put one after the other, without any expression of their connection or relations except (at most) the non-committal connective 'and'" (Abrams, 1988:183). It is contrasted to hypotactic style where "temporal logistical and syntactical relations between members and sentences are expressed by words or phrases" (Abrams, 1988:183). Hence, within the scientific community, within the shared conceptual universe from which I was unknowingly alienated, the accepted scientific language is one which is detached and unconnected. This appears to be consistent with the aims of science: to produce "value free", "objective" truths, scientific language must reflect maximum distance, "unconnectedness" and disembodiment. But Keller points to an implicit contradiction: if scientific ideology is rooted in a metaphor which deems the scientific mind as male, how can the scientific mind be at once male and disembodied? In the latter part of her argument, Keller sets out to illuminate the linking of objectivity (a cognitive trait) with autonomy (an affective trait) and masculinity (a gender trait) that underlies scientific ideology (1982:239).

Using object relations theory, the psychoanalytic tool laid down by feminist psychoanalysts, Chodorow and Dinnerstein, Keller establishes these links. Object relations theory contends that little boys and girls grow up in different kinds of ego boundaries (Fee, 1986:48). Consequently, they have different experiences of their relationships to other people and to the external world. In the context of female mothering, little boys must form their gender identities by cutting themselves off from the mother, the primary love object. Little girls, on the other hand, continue to identify with the mother and do not experience that same abrupt break. In forming a masculine identity, little boys must undergo a process of denial and repression of their early identification with the mother (Fee, 1986:48-49). The consequences of early child development have an expansive scope. In Chodorow's words, the net result is that "the basic feminine sense of self is connected to the world, the basic masculine sense is separate" (1978:169).

Next, Keller invokes Piaget's argument that the capacity for cognitive distinctions between self and other (objectivity) evolve concurrently and interdependently with the development of psychic autonomy. In short, our cognitive ideals become subject to the same psychological influences as our emotional and gender ideals. In this way, along with autonomy, the very act of separating subject from object itself, comes to be associated with masculinity. Ultimately, Keller concludes that "our early maternal environment, coupled with a cultural definition of masculine (i.e., that which can never appear feminine) and of autonomy (i.e., that which can never be compromised by dependency) leads to the association of female with the pleasures and dangers of merging, and of male with the comfort and loneliness of separateness" (Keller, 1982:239). Both the dynamic processes of development that require separation from the mother and cultural definitions of masculinity as independence, reinforce an association of the male with separateness, pushing him to a rigid and exaggerated separation. An important dimension to her explanation is that the maintenance of this male form of individuation is achieved by domination of the "other" (Keller, 1982: 234-240).

Continuing with her endeavor to address the "women question in science" (Harding, 1986:22), Keller reformulates the task for a radical, feminist critique of science, by shifting the approach from an historical to a transformable one. Her concern is to articulate an alternative philosophy of nature - one in which nature's order is perceived as inherent and self-generated, rather than construable as law-governed. She argues that woman's valued participation in science would result in a truly different outlook on nature, and a truly different outlook on science. Only in rejecting sexual polarities which permeate the modern concepts of science and nature, can the study of nature be as inviting to women as it is to men (Keller, 1982:116). The impulse for domination subsided, science could be opened to a more holistic, co-operative, integrative way of theorizing about nature. In Keller's vision, a passage which reads, "the virus in essence, hijacks the metabolic machinery of this cell, turning it into a factory for the production of progeny virus particles" (Southin, 1991:9) would cease to make sense in the name of science.

The "objectivity" that Keller conceives, then, is one characterized by dynamic interaction between the subject and the object of science. Keller postulates a dynamic objectivity which "grants to the world around us its independent integrity, but does so in a way that remains cognizant...of our connectivity to that world" (1985:117). In this way, science can achieve more adequate, reliable representations of nature than those that are available through (masculine) static objectivity. It appears then that, historically, scientific objectivity has been misunderstood. In short, rather than abandon what Keller calls the "quintessentially human effort" (1982:238) to understand the world in rational terms, Keller demands that feminism and science join forces and simply refine this effort. This refinement begins by re-conceiving the very notion of scientific objectivity itself.

While certainly provocative, Keller's analysis is subject to scrutiny. Elizabeth Fee highlights key areas of concern, and reduces the central criticism of Keller's argument to a highly consequential oversight: Keller's analysis appears to explain too much. Psychoanalytic theory, object relations theory in particular, is based on modern, Western, nuclear families within a capitalist economy. Under this paradigm, the mother assumes full domestic responsibility while the father is occupied in the labour force and, therefore, absent from the home. Is Keller's analysis intended to account for gender generally or more particularly to middle class Western societies? Object relations theory is clearly inadequate for the 'general' gender account. Even if Keller's argument is limited to the modern, white middle-class individual, is it still valid to assume a negligible variety in gender related matters, across such a diverse group of individuals?

Fee materializes these suspicions when she looks at the relationship between feminist epistemology of science in Western capitalist societies and epistemologies representing a range of cultural perspectives on nature and natural knowledge (1986:48). What Fee discovers is that while Keller's critique of science addresses scientific ideology as masculine, Black and Native writing addresses scientific ideology as White and European. Moreover, Marxist writing addresses scientific ideology as bourgeois. Concepts of nature that are in one context denounced as masculine, are, in another, denounced as European, colonial, white and bourgeois. While Keller's invokes gender as a unitary analytic category, Fee's analysis reveals this to be problematic. She argues that because gender is not lived independently of other social relations, scientific knowledge is perhaps better seen as a reflection of the "particular moment of struggle of social classes, races and genders found in the real, natural and human world" (1986:55).

In light of this argument, Keller's analysis is exposed as being static and limited. It constructs gender in isolation, and, therefore, neglects to consider the way in which it is constituted through a myriad of social relations. Fee contends that clearly, power cannot be discussed solely in terms of male domination, for maleness is articulated through the matricies of race, class, and so on. It is at this point where Fee's argument takes its most insightful turn, as she shifts the focus from the "women question in science" to the "science question in feminism" (1986:55). As maleness is articulated across several boundaries, so too is femaleness. You cannot be a woman without belonging to a certain class, a certain race, or a certain country, for example. Similarly, a woman exists in a particular moment in history. That moment in history carries its own definition of what it means to be a woman of a certain class, race, nationality and so on. This notion of women (and people) as dynamic "reciprocal selves federated in solidarities rather than essentialized and naturalized identities" (Harding, 1986:55) is a useful tool for contempoary feminism.

Fee is certainly not alone in her criticism of Keller's analysis, nor in her shift of focus. Postmodern critiques assert that the goals of Keller's science are limited by masculine metaphysical and epistemological frameworks. While Keller's analysis engages scientific ideology where the first and second waves of feminism fail, postmodernism asserts that Keller's critique has simply not delved far enough. Keller's notion of objectivity reflects the belief that a more symmetrical gender system will produce a kind of androgynous science. This androgynous science will approach true "objectivity". It is precisely the notion of "true objectivity" that postmodern critique rejects. Instead, the aim of postmodern critique is the elimination of the "defensive androcentric urge to imagine a 'transcendental ego' with a single voice that judges how close our knowledge claims approach the 'one true story' of the way the world is" (Harding, 1986:55).

Postmodern critique, therefore, rejects the notion of the omniscient and omnipotent "transcendental ego" that Keller's analysis invokes. Donna Haraway articulates this rejection by employing a metaphor on the "much maligned sensory system" (1988:581) in political and scientific discourse: vision. Haraway argues that to similar ends, vision has been used to signify a leap out of the social body and into "the conquering gaze from nowhere" (1988:581). According to Haraway, this free-floating gaze is an artifact which mythically inscribes all social bodies while rendering the unmarked category the power to see and not be seen, to "represent while escaping representation" (Haraway, 1988:581). In modern Western culture, this gaze signifies the unmarked positions of Man and White. Furthermore, it is "one of the nasty tones of the word 'objectivity'"(Haraway, 1988:581). In light of this, then, Haraway argues that the key for feminism is the insistence of the embodied nature of vision. In that way, objectivity comes to be understood as nothing less than situated knowledge.

Haraway demonstrates that in late twentith century Western world, technological devices for seeing are conflated with meanings of disembodiment. The vision of "ordinary primates" (Haraway, 1988:582), humans for example, can be endlessly enhanced to the extent that visualizing technologies are without apparent limit. Sonography systems, Magnetic Resonance Imaging, satellite surveillance systems, and electron microscopes are only a few of the devices which illuminate the world from the microscopic cellular level to the global stratosphere (Haraway, 1988:582). Immediately a paradox emerges: these technological mediations are at once celebrated as scientific accomplishments and presented as utterly transparent, as if they were always already there. Objects come to the social human eye simultaneously as "indubitable recordings of what is simply there and as heroic feats of technoscientific production" (Haraway, 1988:582). According to Haraway, this paradox is the effect of the "god-trick" (1988:583): an illusionary view of vision which sees everything from nowhere.

Escaping the mythical promise of the "god-trick", Haraway argues for a revised perspective. She understands this diverse technology as a set of highly specific visual possibilities, each with a wonderfully detailed, active and particular way of organizing the world (1988:583). In Haraway's view, feminist scientists and feminists alike, without giving into the tempting myths of vision as a route to disembodiment, are able to construct a usable but not innocent doctrine of objectivity. Feminist objectivity "turns out to be about particular and specific embodiment and definitely not about the false vision of promising transcendence of all limits and responsibilities" (Haraway, 1988:582) which the "god-trick" purports to accomplish. In short, feminist objectivity is about limited location and situated knowledge, not about transcendence and the splitting of the subject and object.

A key element of Haraway's objectivity is responsibility (1988:582). Unlocatable forms of knowledge harness irresponsibility, which, by definition, evade accountability. Her ideas demand a revolutionary mind-set. She turns the Western cultural narrative, "allegories of ideologies governing the relations that we call mind and body, distance and responsibility" (Haraway, 1988:583) on it's head, to ultimately insist on the eradication of innocence from subordinating systems of knowledge-seeking and knowledge-making.

Haraway's discussion of responsibility is by no means targeted solely at mainstream, phallogocentric discourse. Rather she demands, in fact insists, that feminist discourse adopt this necessary responsible demeanor (1988:587). Haraway contends that the premise of "transcendence" in feminist epistemology is problematic, even antagonistic, to feminist goals. In the past, feminism has relied on standpoint epistemology – the view of the subjugated seemed to illuminate women's experience. The preference for subjugated standpoints is easily understood, for they seem to promise more adequate, sustained, objective transforming accounts of the world. Yet, Haraway warns of the danger in adopting the subjugated position: "To see from below is neither easily learned, nor unproblematic, even if "we" "naturally" inhabit the great underground terrain of subjugated knowledges" (1988:584). She contends that subjugation is not grounds for ontology. However, "it might be a visual cue" (Haraway, 1988:586). Instruments of vision always mediate standpoints, dominant as well as subjugated ones. Ultimately, Haraway argues that it is positioning that is the key practice in grounding knowledge organized around the imagery of vision.

The Gendered Construction of Science: A Reflection.

By Amy Block

This paper was written in my final year of my undergraduate biology degree and marks my first attempt to formalize some ideas about feminism and science that had long been festering. I admit that as a comprehensive literature review, as a feminist critique of "difference", and as a self-performed catharsis, "The Gendered Construction of Science" was devised to serve many purposes. In an attempt to meet these diverse demands, I organized the text in a way that made immediate sense to a self-identified biology major: an evolutionary progression of the feminist critiques of science. In short, I argue that feminist critiques can be categorized sequentially into four discrete impulses. Consistent with contemporary evolutionary paradigms, I demonstrate that each impulse builds on the preceding one. Complicit with the Darwinian conflation of evolution and progress, one will notice that each impulse delves further into 'radical' terrain. Ultimately, I argue that what begins as an attempt to isolate women's participation in science eventually evolves into a project that implicates scientific principles as antagonistic to feminism. I articulate this transition as an adaptive advantage, for it meant that feminist inquiry could finally embrace 'difference' among and between women.

I imagine though, that you could tell the story of feminism and science differently. An evolutionary paradigm operates through particular modes of progression and competition, but what do these modes exclude? How do these modes construct the very story they attempt to merely describe? Even at the onset, the evolutionary paradigm is problematic. In fact, it seems that inscribing a framework of evolutionary progression went against my better instinct. I "supplemented" the critique with my own experiences as a biology student. Yet, these experiences did not accrue over evolutionary time, rather each transpired in the same historical hour; one analysis did not succeed the other. Instead, each held some theoretical power and each met some political and personal need. Used in combination, they ultimately helped me make sense of my experiences as an outraged, alienated biology student. But an evolutionary framework is bound to understand diverse feminist epistemologies as competing – always leaving out the myriad of ways in which things can co-exist non-competitively, mutualistically, cooperatively. In retrospect, then, perhaps the story of feminism and science is better read as epistemological symbiosis. What would that mean for Feminism? What would that mean for Science?

Amy Block is in the combined Master in Environmental Studies and Law Programs at York University. Thanks to Rose-Marie Kennedy for her editorial comments.

Haraway takes the very notion of scientific objectivity, the fundamental building block of modern science, and exposes it as the mythical construct inherent in phallogocentric epistemologies. Instead, she offers a usable and responsible kind of objectivity: embodied situated knowledge. Tracing the waves of feminist critique of science, from retrospection to psychoanalysis, no critique shakes our basic understanding of science to the extent that Haraway's does.

However, in addition to revolutionizing science, Haraway revolutionizes feminism. For Haraway, diverse visualizing technologies are metaphors for 'difference' among and between women. Particular ways of knowing are rooted in her precise notions of what it means to 'be'. But 'being", she argues, is problematic and contingent: "One cannot 'be' either a cell or a molecule-or a woman, colonized person, laborer and so on- if one intends to see from these positions critically" (1988:589). It is the notion of splitting, not being, that is the privileged image for feminist epistemologies. Splitting in this context is "about heterogeneous multiplicities that are simultaneously necessary and incapable of being squashed into isomorphic slots or cumulative lists" (1988:589). Thus, the knowing self is articulated as partial in all its guises- a radical divergence from the essentialized, homogenized subject that Keller depicts. Thus, from the labratory to the classroom, feminist investigations into science charter unforseen territory. Ultimately, feminism has everything to gain: Haraway's partial, locatable, critical knowledges sustain the possibility for feminist coalitions leading to "solidarity in politics and shared conversations in epistemology" (1988:588). Science, on the other hand, will never be the same.

References

Abrams, Meyer Howard. (1988) A Glossary of Literary Terms. 5th ed. Fort Worth: Holt, Rinehart and Winston Inc.

Chodorow, Nancy. (1978) The Reproduction of Mother: Psychoanalysis and the Sociology of Gender. Berkeley: U. of California P.

Fee, Elizabeth. (1986) "Critiques of Modern Science: The Relationship of Feminism to Other Radical Epistemologies," Bleier, Ruth. ed. Feminist Approaches to Science. New York: Pergamon Press.

Gunew, Sneja and Anna Yeatman. (1993) Feminism and the Politics of Difference. Halifax: Fernwood Pub.

Haraway, Donna. (1988) "Situated Knowledges: the Science Question in Feminism and the Priviledge of Partial Perspective," Feminist Studies. 14, 3: 575-599.

Harding, Sandra. (1991) Whose Science? Whose Knowledge? Ithaca: Cornell U.P.

_____. (1986) The science Question in Feminism. Ithaca: Cornell U.P.

Keller, Evelyn Fox. (1992) Secrets of Life. Secrets of Death. New York: Routledge.

_____.(1985) Reflections on Gender Science. New Haven: Yale U.P.

_____. (1983) A Feeling for the Organism. New York: Freeman Press.

_____. (1987) "Feminism and Science," Sex and Scientific Inquiry. Sandra Harding and Jean F. O'Barr. eds. Chicago: U. of Chicago P.

Longino, Helen E. (1988) "Science, Objectivity, and Feminist Values," Feminist Studies. 14,3 Fall: 561-574.

Schiebinger, Londa. (1987) "The History and Philosophy of Women in Science," Sex and Scientific Inquiry. Sandra Harding and Jean F. O'Barr. eds. Chicago: U. of Chicago P.

Southin, John L. (1991) Cell and Molecular Biology. 2nd ed. Dubuique: Kendall/Hunt Pub.

by Robert Plitt

The representation of nature in text and image presents specific problems. Central to this challenge is the distance between the thing one verbally or visually articulates and the thing itself. The exploration, paradoxically, may distance one from the subject one wishes to get closer to. How does one describe nature? One method is through a scientific description of the parts which represents its meaning and presumably brings us closer to an understanding of it. Nature in this sense is known objectively. Alternatively, nature can be understood as a reflection of culture. In this case our perception of nature will be directly connected to how we perceive ourselves in it. The work that follows is an attempt to integrate the two disciplines of science and art proposing that the distance between our human experience of nature and the language we use to describe that experience be diminished.

Natura bumblebee

identification of aulocara species

elliott

1. forewings extending beyond end of abdomen
2. dorsal field of forewings usually with pale median stripe along entire length, originating at pronotum
3. face without small black vertical streak above front articulation of mandible
4. body length to end of hind femora 16-25 mm in males, 22-35 mm in females

Sugar Maple

large tree with rounded dense crown and multi colored foliage in autumn.
Height: 70-100'
Diameter: 2-3'
Leaves opposite; 3 1/2-5 1/2 " long and wide; palmately lobed with 5 deep long pointed lobes; few narrow pointed teeth; 5 main veins from the base; leaf stalks long and often hairy on veins beneath; turning deep red, orange, and yellow in autumn

Bark: light grey; becoming rough and deeply furrowed into narrow scaly ridges
Twigs: greenish to brown or grey; slender

This makes me think about the William Carlos Williams' poem The Red Wheelbarrow. Although I don't have a copy at hand I will attempt to remember it.

So much depends upon
a red wheelbarrow
glazed with rainwater
beside the white chickens

Two ways of seeing the world seem to be expressed by the description of the maple and the poem. It seems that the two ways of seeing the world are in stark contrast with one another. Williams attempts no explanation of the meaning of the objects in his poem. The wheelbarrow is not defined by its parts. The wheel, the handle with its corresponding length and width. It is not described by the type of wood it is composed of nor the capacity it has for holding weight.

I am caught between a maple and a wheelbarrow.

How to look at the world.

Robert Plitt is a graduate student in the Faculty of Environmental Studies at York University. The inspiration for his work was born from time he spent on a small organic farm in southwestern Ontario. He would like to acknowledge the efforts of Toni Greenwood in managing her farm and her generosity in welcoming him into her challenging environment.

CAVEAT MANIPULATOR: (Re)forming

By Tres Fromme

Geographic Information Systems (GIS) have, within the last few years, engaged the interests of academics and professionals in the many fields- cartography, geography, computer science, remote sensing, and statistics among others-at whose intersection GIS emerges. An acknowledged limited survey of the writings and issues indicates that much of the material concentrates on methods, technologies, and applications. The dominant tone of the research and work is positivistic and rareified, as if GIS existed outside of any social situation. Writers enthusiastically concern themselves with data models, (hard/soft)ware issues, and quantifiable results and measures.

GIS technology allows for the dynamic collection, storage, recall, and manipulation of facts and data that are directly linked to geographic phenomena through maps. The synergisitc combination of information and analytical techniques from traditionally segregated disciplines and practices permits a high concentration of knowledge in one locus and in the service of an individual or group. GIS knowledge, moreso, is closely linked to physical space and the description and production of that space; abstract information is readily located in the physical world. As abstract informational landscapes immediately coincide with geological landscapes, the potential for control of various contested terrains emerges. The darker side of GIS' capabilities, however, has rarely been addressed.

Aangenbrug (1991) lists several weaknesses of GIS, one of which seems particularly reflected in the GIS literature. He includes the criticism that writers only present the "feel good" successes of their explorations, rarely mentioning failures and difficulties in respect to developing and implementing GIS. This comment appears to address only to the techno-economic issues surrounding GIS. Where are discussions of the direct or indirect failures or even successes of the GIS in respect to cultural and social issues?

Thomlinson comes close to posing a similar question when he lists problematic institutional and organizational acceptance and implementation of GIS as one of the major difficulties facing the development of the technology (Clarke,1991). Indeed, several other authors stated that "the most common reasons for failure [of GIS] are now organizational weaknesses or political naivety" (Rhind et al., 1991: 9) These organizational problems might very well present a model for GIS integration into the greater milieu of contemporary culture. If GIS generates or uncovers problems of power and social structure at the microlevel of the agency or department, what disturbances will it send rippling through overall social relations?

Even though authors such as Couclelis (1992) have dealt with issues of humans and perception in creating GIS's representational space, and authors like Epstein (1991) have addressed the issues of economic and legal issues, their work still exhibits a scientific bias that treats humans, the law, and the economy as objects of empirical scrutiny and experimentation. In other words, though dealing with cultural issues, their analyses do not focus beyond the realm of traditional "scientific" discourses.

The fields collectively known as "cultural studies" or "social criticism" also seem to have ignored the issues presented by the development of GIS. Perhaps this omission results from the recent emergence of the technology as well a certain discomfort with GIS on the part of the "humanities." Both fields, ironically, aspire to interdisciplinary inclusion and synergy.

This paper attempts to engage certain "postmodern" thinkers to critique GIS in respect to power relations and "metanarratives." Admittedly, the discussion will be brief and cursory but will hopefully provide a cultural critique less positivistic than many of the current GIS debates.

No technological development is "innocent"or autonomous, but instead exists at the intersection of many generative forces. There is a strong social and cultural component not only to technological applications but to the very formations of economic, academic, and political discourses and economies. These discourses call the technology into being and are, in turn, modified by the technology. The potential for a technological development to not only reify but also to replenish the oppressive power from which it emerges must not be ignored.

Throughout his career, Michele Foucault traced the intersections of power, knowledge, society, and the social body (which emerges from the play of power and knowledge). Foucault recognized that certain social phenomena do not generate new technologies and modes of organization but are generated by those technologies. He also observed inextricable connections between power and knowledge (Foucault, 1980). These realizations warned against accepting as absolute and "natural" (and thus unchangeable and unimplicated in power relations) ideas, social relations, and even forms of "human nature." Foucault recognized these as actually (re)produced by cultural discourses and forces.

For example, Foucault's Discipline and Punish traces the construction of the modern soul and the genesis of the modern penitentiary to reform this soul. He links this formation to, among other things, the rise of the Bourgeoisie and its need for certain economic and social freedom from monarchies (Foucault 1979). Social discipline and organization created "the" individual in an attempt to eliminate all "social and psychological irregularities" and to produce "useful and docile subjects through a refashioning of minds and bodies" (Best and Kellner, 1991: 47). The technology of the prison, the organization of space and the individual, sought to control and fashion a population that would eventually regulate itself. This allowed the *status quo* to expend energy elsewhere that would previously have been spent in forcefully repressing its members (Foucault 1980).

Marshal McLuhan also connects the transformation of technologies to radical changes in institutions, modes of thought, and human subjectivity (often a product of the previous two factors) which result in entirely different constructions of "reality" (McLuhan 1967). His suggestion that "societies have always been shaped more by the nature of media...than by the content of the communication" particularly bears on GIS (McLuhan, 1967: 8). The aggregate form of GIS technology-instant and extensive computer manipulated and maps and data- may be "new" but the classes of information involved – records, deeds, property boundaries – are not. The ability of GIS to allow swift and comprehensive collection (satellite surveillance), analysis (overlays), transformation (scale enhancements), and dissemination (electronic transmissions) of geographically linked data places old contents in a potent emergent medium.

McLuhan traces how the development of narrative writing as the description of a newly quantifiable world (based on a linear perspective) altered human consciousness and culture by compartmentalizing reality into discrete and sequential moments. An ordered, "assembly line" regimentation of institutions and social relations followed this twist of consciousness as the medium of communication modified and created the content being transmitted (McLuhan 1967). The Medium is the Message concludes with a manifesto for a "new" world and individual (re)formed by the constant stimulation,

Geographic Information Systems

the "message," of twentieth century electronic media. GIS, electronically immediate and transgressing traditional boundaries, embodies one of these media that challenges the old consciousness based on discrete and compartmentalized information.

GIS then, as a socio-political discipline and medium, appears to contain the potential for creating new disciplinary (or institutional) structures and, therefore, human subjects. How might GIS (re)form the individual and her relations to society? One must not presume GIS users, especially within an academic context, to operate outside of strategies of control.

Indeed, GIS bears an uncanny resemblance to Foucault's concept of the "Panopticon." The panopticon, embodied in Jeremy Bentham's eighteenth century prison design, offers a model of centralized surveillance where an organizing core is able to train its gaze on each individual within the system (Foucault 1980). This gaze directs and molds the subject through allowing what can and can not be said or performed. This panoptic system expands to replicate and generalize itself throughout social relations. For example the use of "dossiers, systems of marking and classifying, [and] the integrated accountancy of individual records" (the realm of GIS data!) as well as architecture and planning allows for surveillance and control of the population and its affairs (Foucault, 1981: 71). GIS technology expands the limited site/sight line of the panopticon in its ability to interconnect with spatially and temporally distant electronic systems through information technologies.

The oft-touted abilities of GIS users to analyze, collect, transfer, and quickly synthesize information of both a spatial and qualitative content might very well serve as a panoptic system (or series of integrated systems) for control of social relations. The technology's capabilities for record keeping and locational analysis might facilitate a totalizing system of surveillance and monitoring. Doubtfully could any one organization could use GIS to dominate a plural and culturally fragmented culture (as Jim Collins has suggested in a critique of Foucault in his 1989 Uncommon Cultures). However, multiple and perhaps competing groups might employ the technology on micropolitical levels and scales of influence. What new disciplines might it establish and how?

Philosopher Jean-Francois Lyotard's idea of grand "metanarratives" (Progress, Liberation, etc.) with which Western culture once attempted to generate a homogenous cultural system might suggest a means by which GIS could develop social control. Looking specifically at the metanarrative of Enlightenment-derived, Western, scientific discourse, Lyotard locates the "flaws" that undermine the supposed absolute autonomy of science (Lyotard 1984). His analysis deprivileges and demystifies the authority and power that circulate within the positivistic economies of scientific knowledge production. Once the "halo" is stripped from science, science's epistemological grounding is revealed as, not absolute laws of nature, but rules as arbitrary as those of any other discipline.

GIS users' desire for standardization and universalization does indeed instigate what Rhind et al. (1991) label a "technological imperialism" as a few world powers colonize developing countries with an alien, abstract technology and technological language that forms into a scientific metanarrative or discursive hegemony (and parallels the political and cultural heegemonies of Western culture imposed on developing nations). The need for GIS to locate, catalog, and quantify information on both global and minutely detailed levels seeks to (real)ize everything, to, in Lyotard's words, "supply reality" to an almost neurotic degree. GIS, in this view, could emerge as a force of aggression and violent colonization of almost every social aspect, both spatial and non-spatial. Everything will be revealed and subsumed into the universal databases of the system that imposes a "return of terror" Lyotard associates with metanarratives (Lyotard, 1993: 46).

Though the collapse and deprivileging of the various modernist metanarratives disallows a complete hegemonic domination, multiple totalizing schemes might possibly arise within localized cultural spheres. GIS could easily serve as an agent of a renewed hegemonic impulse. Those who control the development of the systems control the very structure and discourse of those systems. They control what can and cannot be said and thus thought into existence, the discipline of Foucault. Following Foucault, these reimposed metanarratives generate new subjects and subject positions. Any definition of terms could easily serve to privilege the cultural status of the creators while excluding the identities and voices of those marginalized in the development process.

The issue of language and linguistically-influenced concepts in respect to GIS provides a good example of marginalization (Frank and Mark, 1991). As Roland Barthes and others have realized, language is intimately connected to power and the realization of that power in the world (Eco, 1987). Those who currently lead GIS development appear to hail from predominantly western, English-speaking countries: The United Kingdom, the United States of America, Canada. If not a native speaker of English, then an individual's research appears to be largely translated into and shared in English as perhaps a new "Latin," or dominant language of scientific pursuit.

As research and communication develop in a hegemonic language, certain concepts of space and organization in other languages are lost in the translation (Frank and Mark 1991). Indeed, cultures often structure space and the experience of space/time in radically different manners from each other. These concepts then precipitate into the native language and culture (Hall, 1969). Translation can become difficult if not impossible. One not familiar with the dominant language is forced to grasp a new tongue and conceptual world (assuming such is fully possible) or to submit to the dominant discourse of the system, to be colonized and to abandon their own linguistic environment.

If both culture and landscape exist as polyglot matrices of perceptions, discourses, and idiosyncratic responses (as well as hard data) then any attempt to totalize or quantify that landscape in terms of one system or standard has the potential to obliterate the multiplicity of landscapes to some degree. Cultural Geographer D.W. Meinig identifies a modest ten frameworks operating in American culture through which individuals interpret the landscape (Meinig, 1979). The systems of GIS I am familiar with encompass less than half of these. Should GIS technology become the privileged and "valid" means of describing, interpreting, and approaching the landscape through its databases and cartographic perspectives, then much of the landscape will have been lost to the detriment of those invested in the marginalized frameworks.

GIS, unlike previous technologies, might have the power to generate something approaching a landscape metanarrative due to its multidisciplinary and electronically systematic (and almost instantaneous) structuring. If standards and univeral languages for the GIS community crystallize, then any discipline that uses GIS will subsume part of its own discourse within that of GIS, so what is essentially a fragmented and plural matrix of voices and perception

PHOTO: GUY LETTS

could become transversed and subordinated to an overarching discipline of GIS. GIS vocabulary further limits a language already limited in its ability to describe the world.

Cultural critics such as Jim Collins who see hegemony and other theories positing a central, controlling, power are correct in identifying "postmodern" North American culture as one incapable of being subsumed by any one group or interest due the sheer multiplicity of identity groups (Collins, 1989). However, might not such a "new" discipline and technique such as GIS throw this assumption into question? GIS technology's ability to collect, analyse, represent, store, and transmit immense amounts of interconected information concentrates in one set of techniques and data an unprecedented amount of knowledge and power.

As various scholars have forwarded, "representations are social facts" that construct the world individuals perceive and within which they dwell (Rabinow, 1986; Milgram, 1984). Those who control the representations or the modes of representation can thus control the "reality" individuals know. GIS with its cartographically-derived concerns over representational strategies might actually limit possible representations of the landscape and thus limit the actual *landscapes* possible for realization. As McLuhan posits:

> *Media, by altering the environment, evoke in [individuals] unique ratios of sense perceptions. The extension of any one sense alters the way we think and act – the way we perceive the world (McLuhan, 1967).*

Might not conservative factions mobilize GIS technology to (re)collect the disparate fragments of culture within a time of radical pluralism where meaning is relative, multiple, and where no great myth unites various identity groups? Through an almost complete and limitless capability to control economies of knowledge/space/representation, GIS might radically change the very nature of the landscape and thus the individual in an environmental context and reinforce modernist notions of a universal culture of Man? Some of these concerns may seem to border on Orwellian paranoia, but GIS technology has, by its own presumptions, almost unlimited possibilities for social restructuring.

Academics have an obligation to explore and trace the lines of influence and force which this technology is generating and will only continue to produce. Beyond the positivistic concerns with data quality, processing times, and other "hard science" issues hovers the human population whom these technologies will radically effect.

Tres Fromme recently received his Masters of Landscape Architechture from the University of Georgia. He is currently working as part of a team developing the long range master plan for Longwood Gardens in Kennett Square, Pennsylvania. Current research includes applications of Oscar Wilde's various aesthetic philosophies to a deconstruction of Nature discourses in lanscape architecture and garden design. His previous contributions to *Under-Currents* include "S(t)imulate Me: A Loose Manifesto" (Vol. 7).

References

Best, Steven and Douglas Kellner (1991) Postmodern Theory: Critical Interrogations. New York: The Guilford Press.

Collins, Jim (1989) Uncommon Cultures: Popular Culture and Post-Modernism. New York: Routledge.

Clarke, A.L. (1991) "GIS Specification, Evaluation, and Implementation," In Geographical Information Systems: Principles and Applications vol.1: Principles, eds. D.J. Maguire, M.F. Goodchild & D.W. Rhinds, 477-488. Essex, England: Longman Scientific and Technical Publications.

Couclelis, Helen (1992) "People Manipulate Objects (but cultivate Fields): Beyond the Raster-Vector Debate in GIS," In International Conference GIS – from Space to Territory: Theories and Methods of Spatio-Temporal Reasoning in Geographic Space, eds. A. Frank, I. Campari & U. Formentini, 64-77. Pisa: Springer-Verlag.

Eco, Umberto (1987) Travels in Hyperreality. London: Pan.

Epstein, E.F. (1991) "Legal Aspects of GIS," In Geographical Information Systems: Principles and Applications, Volume 1: Principles, eds. D.J. Maguire, M.F. Goodchild & D.W. Rhind, 489-502. Essex, England: Longman Scientific and Technical Publications.

Foucault, Michel (1979) Discipline and Punish. New York: Vintage Books.

Foucault, Michel (1980) Power/Knowledge: Selected Interviews and Other Writings 1972-1977. New york: Pantheon Books.

Gutpil, S.C. (1991) "Spatial Data Exchange and Standardization," In Geographical Information Systems: Principles and Applications, Volume 1: Principles, eds. D.J. Maguire, M.F. Goodchild & D.W. Rhind, 515-530. Essex, England: Longman Scientific and Technical Publications.

Hall, Edward T. (1969) The Hidden Dimension. Garden City, New York: Anchor Books.

Lyotard, Jean-Francois (1993) "Answering the Question: What is Postmodernism?" InPostmodernism: A Reader, ed. Thomas Docherty, 38-47. New York: Columbia University Press.

Lyotard, Jean-Francois. (1984) The Postmodern Condition: A Report on Knowledge. Minneapolis, MN.: University of Minnesota Press, 1984.

McLuhan, Marshall and Quentin Fiore (1967) The Medium is the Message. New York: Random House.

Meinig, D.W. (1979) "The Beholding Eye: Ten Versions of the Same Scene." In The Interpretation of Ordinary Landscapes: Geographical Essays, ed. D.W. Meinig, 33-51. New York: Oxford University Press.

Milgram, Stanley (1984) "Cities as Social Representations." In Social Representations, eds. Robert M. Farr & Serge Muscovici, 289-309. London: Cambridge University Press.

Rabinow, Paul (1986) "Representations are Social Facts: Modernity and Postmodernity in

Anthropology." In Writing Culture: The Poetics and Politics of Ethnography, eds. James Clifford & George E. Marcus, 234-262. Berkeley CA: University of California Press.

Rhind, D.W., D.J. Maguire, and M.F. Goodchild (1991) "Introduction." In Geographical Information Systems: Principles and Applications,Volume 2: Applications, eds. D.J. Maguire, M.F. Goodchild, and D.W. Rhind, 515-530. Essex, England: Longman Scientific and Technical Publications, 1991.

Blue planet in a darker heaven

ca 2 Ga (and earlier)

By Joanna Beyers

Before geography
land has no mandate or mission.
Peninsulas, lagoons, bays
unnamed, do not exist.
The planet simply propels itself
through space
spins without consciousness
sullen days and longer years.

In shallow oceans, in mats
away from the potent sun,
cells divide. Otherwise
only rocks are alive –
from bare slopes, in changeable beds
cut by fickle streams
they carry time like willing beasts.

The Non-Science Science of Complexity Theory: Towards a New Scientific Construction of Nature

By Guy Letts

Introduction

In pre-Enlightenment, nature and people were seen as being the determined creation of a divine God. The Aristotelian-Christian world view believed that the world was hierarchically ordered wherein everything had a rightful place and purpose in a divinely created and ordered universe. The Enlightenment challenged this view asserting that the world existed as part of a system that obeyed "natural laws." What was fundamental to the scientific view of the Enlightenment was the strong link it made between reason (represented by humanity) and nature (everything outside of the socio-cultural realm). The Enlightenment concept of nature stressed that the universe was a mechanical system comprised of matter that was in constant motion, which followed the physical laws of nature. It was believed that through reason, individuals and society could become versed in the "laws of nature" which would lead to a peaceful and harmonic co-existence with nature and the universal order (Seidman, 1994:20-21; Touraine, 1995:15).

The influences of the Enlightenment still remain very much alive today. While the ideals of the Enlightenment are no longer a bound, unified concept, the principle strength of modernity still lies in the adage "trust in science." Instrumental reason and modernization are themselves both the construction of a rationalist image of the world that attempts to integrate humanity with nature (Seidman, 1994:6, 25-26; Touraine, 1995:28-33).

With new theoretical developments like quantum mechanics, string theory, chaos theory, and complexity theory, many of the assumptions posited by Enlightenment thinkers about nature are being challenged in much the same way that the Enlightenment challenged the Aristotelian-Christian view of nature. Complexity theory refutes the Enlightenment and modernist view that the natural world is an ordered, mechanistic system. Rather than being simply ordered and mechanistic, complexity theory suggests that all complex systems, whether natural or cultural, are also disordered, chaotic, fluid, and unpredictable. This new scientific interpretation of the world challenges traditional scientific assumptions and models of nature and society. The following paper will provide a general outline of complexity theory and demonstrate how this new paradigm challenges the modernist constructions of nature as an ordered, mechanistic environment with a more desirable model that is dynamic, fluid, and interdependent.

Complexity Theory

Complexity theory developed out of the surrounding research on chaos theory. While chaos theory focuses on the hidden order that resides within chaotic systems, complexity theory is concerned with how ordered, complex systems spontaneously emerge out of chaotic systems. This spontaneous emergence of ordered, complex systems is often referred to as *self-organization*, or emergent complexity. What makes complexity theory unique then, unlike chaos theory, is its ability to account for structure, coherence, and the self-organizing process of complex systems. Complex systems then, are not merely *complicated*,[1] static objects, but non-linear, spontaneous, disordered, self-organizing, adaptive systems (Ditto & Pecora, 1993:78-79; Hayles, 1991:12; Waldrop, 1992:11-12). The notion of 'adaptiveness' is an important one. Allen points out how adaptability is central to complexity in the following passage:

> *It is about 'adaptability', and the capacity to become aware that circumstances have changed and to produce new solutions. Not only that, it is also true that this ability to produce innovation and change will drive circumstances of others and drive evolution itself, favouring individuals capable of dealing with change, and eliminating those that are incapable (1994: 584).*

Rather than passively responding to events, complex systems actively attempt to turn circumstances to their advantage. It is this innovative awareness and reflexive characteristic that gives complex systems their dynamism and life-like quality.

The foundation for complexity arose out of the second law of thermodynamics which states that in a closed system, entropy (S) – a function of absolute temperature – always tends to increase. In other words, in every real heat exchange a proportion of heat is always lost to 'useful' purposes, also known as the *universal tendency toward dissipation*. In this model, heat is constantly dissipated until the universe expends its entire heat reserves. In a system of constant dissipation the mean temperature would eventually stabilize at just above absolute zero, and all life would cease to exist – this teleology is often referred to as *heat death*. The idea that the universe is in a constant state of approaching zero, and in a downward spiral that increasingly becomes disordered as heat dissipates could not be further from the truth (Hayles, 1991:12-14). Prigogine and others have posited entropy as the engine that drives the world to increased complexity rather than disorder. They argue that in systems far from equilibrium, entropy production is so high that any decreases in entropy can take place without contradicting the second law, and that under certain circumstances this same mechanism can allow systems to engage in spontaneous self-organization (Prigogine, 1984:117-122, 272-277, 295-297). Entropic disorder, then, plays a constructive role in creating order which suggests that the universe has the capacity to renew itself.

After Prigogine, Gunzig, and Geheniau linked entropy to cosmology, the theory of complexity and self-organization began to be applied to evolutionary biology, economics, and other systems that shared similar dynamics (1984:115). Complexity is found in dynamic, nonlinear systems and can explain the structure, coherence, and self-organization of complex systems which exist *at the edge of chaos* (a phase space where life is afforded enough stability to sustain itself and enough creativity to be adaptive) where dynamic systems have the ability to balance order and chaos simultaneously.[2] This balance lies within a system which is never quite stable and yet never quite turbulent (Hayles, 1991:13-14; Prigogine, 1984:115-117; Waldrop, 1992:11-12, 293). As Waldrop has described it, "the edge of chaos is the constant shifting battle zone between stagnation and anarchy, the one place where complex systems can be spontaneous, adaptive, and alive" (1992:12).

The edge of chaos is a position or 'phase transition' between two extremes and it is in this phase transition that one finds complexity. While a first-order phase transition refers to the sharp and precise point or moment of change from one state to another, second-order phase transition, the kind found in complexity, occurs much less abruptly. At the equilibrium of a second-order transition, order and chaos are balanced and intertwined in a complex and changing flux (Waldrop, 1992:229-230). Langton developed three examples that illustrate a state of phase transition:

Figure 1

Cellular Automata Classes:
I & II → IV → III

Dynamical Systems:
Order → Complexity → Chaos

Matter:
Solid → Phase Transition → Fluid

It is in phase transition that information can be both stored and transmitted. In the example of the cellular automata classes, structures governed by rules I and II could store data, but would be too static or ordered to transmit the information; similarly, data in a chaotic class III environment would get lost amidst the noise (uncoded matter-energy).[3] Langton concluded that only a class IV environment can provide the stability necessary to store information and enough fluidity to transmit signals across arbitrary distances. Thus, the rules necessary for the storage and transmission of information are those that reside in the second order phase transition, at the edge of chaos (Waldrop, 1992:231-232; Wilden, 1980:xix).

What is fundamental to the process of increased complexity and the emergence of spontaneous self-organization is the role of the agent. In complexity, systems are made up of a network of agents that act in parallel. It is important, here, to think of agents as a plurality. That is, agents can either be individuals or 'collectivities'. For example, households, cities, provinces, or countries can all be seen as agents depending on what level or system one is examining. Regardless of the category though, the environment of the agent is produced through interactions with other agents within a given system. That is, agents are constantly acting and reacting to what other agents are doing in the system. Because of this, the environment is always dynamic, fluid, and unfixed. Moreover, the agents themselves have to be dispersed (as opposed to being centralized) if there is to be any coherent behaviour in the system. What is central to complexity theory is the notion that coherent behaviour can only arise out of competition and cooperation among agents themselves (Waldrop, 1992:145).

In any adaptive, complex system there are many levels of organization wherein agents at one level serve as the "building blocks" for agents at a higher level of organization. For instance, individual workers make up a department, several departments make up a division, and several divisions make up a company, and so forth. What is of importance here is that adaptive, complex systems continually revise and reorder building blocks as each level of organization gains more experience similar to the modification, reorganization, and adaptation that occurs in the process of evolution. Whether we are speaking of cells, neurons, organisms, politics, or economics, the processes of learning, evolving, and adapting are the same within each level of organization (Waldrop, 1992:145-146).

An adaptive agent will exploit certain environments to fill niches which exist in all complex, adaptive systems. If an agent already has an adaptive trait that corresponds to a particular niche, it will exploit that niche in order to fill it. Further, when one niche is filled, other niches will open up for new symbiotic partnerships. Thus, new opportunities are constantly being created. As a result, a complex system can never reach equilibrium because it is always unfolding, becoming, and in transition. In other words, complex systems are characterized by perpetual novelty. If a system ever reached the point of equilibrium, it would become static and stable which would result in its death. As such, agents can never maximize their utility or optimize their fitness because the possibilities are too diverse to ever find the optimum. The agent can only change, improve, and adapt relative to the behaviours of other agents in the system (Waldrop, 1992:147).

Inter/dependent Hierarchies

The idea that adaptive, complex systems are multi-layered, interlinked levels of organization emphasizes their adherence to hierarchical properties rather than being a dualism or binary opposition. Wilden has poignantly observed that many of the assumptions about oppositions are often unfounded and *imaginary*.[4] For example, the relationship between nature and culture might be described as an opposition; however, this 'oppositional' relationship only exists as an imaginary metaphor. To describe nature and culture as opposites does not accurately depict the relationship within the context it was intended ($ab = xy$). Rather than opposites, the relationship between nature and culture can more accurately be described as a dependent hierarchy. That is, culture is necessarily dependent on nature, but nature is not dependent on culture ($ab\ xy$). Thus, any relationship between levels in a hierarchy, whether they are contradictory or not, does not constitute an opposition. Such 'oppositional' metaphors, then, do not provide accurate descriptions of natural relationships as much as they represent deeply rooted social values. Wilden notes that while many oppositions are imaginary representations of real relations, 'real' oppositions do exist. In a true relation of opposition, both terms or systems must be interchangeable without affecting the relationship between them (Wilden, 1981:4-9). That is, they must be commutative and of the same logical type ($xy = yx$).

By hierarchy, I am referring to the *near-decomposability* of different orders of organization and interaction. If we think of a set of Chinese boxes whereby opening any given box reveals a smaller set of boxes, and opening any one of those reveals yet another set of boxes, and so on, then we can understand the notion of multiple levels of organization and systems. The direction of hierarchies in adaptive, complex systems, however, are contrary to the traditional model of hierarchies which are ordered top down.[5] Hierarchies in complex systems are based on the idea of building blocks which makes higher levels dependent on lower ones. This inversion promotes "grass roots" or bottom-up organization. Moreover, as one level builds on top of the next, each new level of organization becomes increasingly more complex (O'Connor, 1994:611; Waldrop, 1992:333).

The possible activities of a particular system or subsystem, however, are limited and constrained in dependent hierarchies. An example of this can be seen in Wilden's use of the *extinction rule*. The extinction rule can be used to orientate a complex, dependent hierarchy. By eliminating different levels of the hierarchy, we can determine which levels are necessary and which will become extinct if removed. For instance, if we use inorganic, organic, and socio-cultural categories, the hierarchy can be illustrated as follows:

Figure 2

inorganic nature

organic nature

socio-cultural

If we now apply the rule of extinction, it becomes apparent that if we eliminate either the inorganic or organic environments, the socio-cultural environment will cease to exist. Moreover, if we only eliminate the inorganic environment, then neither the organic nor socio-cultural environments can exist. However, if we eliminate the socio-cultural environment, the organic and inorganic environments will still thrive (Wilden, 1980:xxxv; 1981:3-4).

Not only is each environment dependent on the one before it, but each environment is critical in the formation of the next. That is, each time a new adaptive self-organizing system emerges out of the last, it becomes increasingly more complex. This, however, does not mean that higher levels of organization can not affect or impact on lower systems. Take for example, the impact that socio-cultural systems and human behaviour have had on both organic and inorganic systems. Changes to lower systems that are the by-product of human behaviour will also change the patterns of those same human systems as they are forced to readapt and modify to changes in the organic and inorganic environments.[6] That is, because they are dependent, they are necessarily interdependent. The belief that there is an autonomy of system components which have distinctive behaviour and creativity no longer holds true in complexity. That is, the properties that an element displays are not seen as being intrinsic to the object itself. Rather, discernible components in conjunction with their properties emerge within a collective regime of activity. Both *the objects and properties are the co-effects of the totality of their interactions*. Thus, a single element can only be understood in terms of its inter-relation and inter-being with the rest of what it is (O'Connor, 1994:611-612; Waldrop, 1992:145, 176, 349).

In adaptive, complex systems the relations and interactions *between* interdependent parts are of greater importance than the individual agent itself. In other words, it is the interaction and connections between individuals rather than the individuals themselves that are responsible for the creation, maintenance, and renewal of systems and structures. However, under certain circumstances minute inputs or minor fluctuations in a system may be amplified which can result in systemic change. Such systemic and structural change can be facilitated by an individual through replication errors and mutations which become amplified by positive feedback (as reflected in the *butterfly effect*[7]). Thus, an individual agent can play a fundamental role in creating and changing systems. The control of networks and complex systems, however, is generally dispersed rather than being centralized. It is in the distributive nature of control and bottom-up organization of complex systems which makes them impossible to specify and predict. Complexity theory, then, is a dynamic model that allows for the innovative and creative emergence of new levels of complexity and spontaneous self-organization (Waldrop, 1992:348-350).

Scientism Revisited?

While complexity theory deconstructs the modernist notion that there is an element of control and certainty in science, it also positions itself as a totalizing theory. However, as poststructural critiques of modernity have demonstrated, there is no universality that marks the world – rather, the world is made up of differences (Seidman, 1994:231). While complexity theory asserts a totality, it is a totality of difference and ambiguity. The metaphor of multidimensional phase space (see *Figure 1*) allows for the plurality of legitimate perspectives which are the foundation of diversity. Thus, while complexity is a theory of unity (i.e., *all* complex systems are adaptive, unpredictable, and dynamic), it simultaneously challenges the Enlightenment assumptions that have either sought or imposed the ideals of foundationalism and "universal truth." Unlike the Enlightenment then, complexity is both unifying and fragmenting. It is in emergent complexity were the contradiction between hegemonic reductionism and fragmented relativism can be resolved[8] (Funtowicz & Ravetz, 1994:569). The danger lies in the perception that complexity is, in and of itself, a totality without recognizing that such totality necessarily involves change, difference, chaos, and fragmentation.

The idea that complexity is an all encompassing theory which can be used as an explanatory model for biological evolution, consciousness, weather patterns, earthquakes, revolutions, social change, and the stock market also reflects something about its links to the Enlightenment (Appignanesi et.al., 1995:109). That is, there is a propensity to invest complexity theory with the modernist ideal of positivism. The term positivism, here, refers to the social/scientific search for a grand organizing principle that unifies the world (Bullock et.al., 1988:669). In much of the literature there is a positivist subtext that states, "if we could only know everything we could solve the world's problems." However, the subtext of positivism is contradicted by the very nature of complexity. That is, you cannot "know everything" in a world that is unpredictable and has no certainty. Thus, despite positivist overtones, complexity itself cannot sustain a prolonged dialogue with positivist ideals.

It might be argued that by ordering systems in a hierarchy of increased complexity, levels that are more complex might be interpreted as being superior. However, the notion that one level is superior over another does not account for the dependency that "higher" complex levels have on "lower" levels. Moreover, because lower levels act as the general environment for higher levels, the lower levels are broader, more adaptable than are higher levels (see *Figure 2*). It is in the lower levels of complexity were change is generally initiated from. Thus, it could be just as easily argued that lower levels of complexity are superior to higher levels. However, because levels are interconnected, any level that is relegated to "subordination" can potentially set off a chain reaction that will result in systemic change to other levels in the system.[9] Because there is no distinction between the initiators and receptors in an interlocking network, any action that favours a particular group or order faces the unpredictable adaptation of the overall system. Thus, any action (intentional or unintentional) may set in motion a chain of events that will form different patterns for the initiator to adjust to (Waldrop, 1992:333). Thus, illustrating levels of complexity hierarchically does not infer a hierarchy of dominance, but of complexification.

Complexity theory should not be confused with earlier, more static models like 'ordinary complexity' and systems theory. In models of 'ordinary' complexity or systems theory, behaviours are explained as mechanisms that serve a functional teleology. In biological systems, for instance, the goal is growth and survival. The normal state of such a system is a diversity of elements that coexist in a complementary environment of cooperation and competition. By contrast, emergent complex systems cannot be fully explained through functional or mechanical means because elements of the system possess individuality, 'intentionality', consciousness, foresight, purpose, and symbolic representation. Thus, any attempt to reduce natural, cultural, and societal systems exclusively to the realm of ordinary complexity can result in unrealistic empirical models. Furthermore, ordinary, mechanistic complexity cannot explain the concept of novelty. In emergent complexity, however, continuous novelty is considered a characteristic property. With its ability to deal with novelty, emergent complexity better reflects the dynamic flux of both natural and cultural systems (Waldrop, 1992:242; Funtowicz & Ravetz, 1994:570-571).

Assuming 'survival' or adaptability as the *only* thing that counts in a system is both 'reductionistic' and dangerous. Mechanistic scientific world views blame and punish the weak which leads to a logic that goes beyond morality similar to that found in eugenics. Emergent, complex self-organization can be applied as a heuristic device to deal with the more technical context of systems theory. However, any description of systems and relations, such as *competition*, necessarily structures our perceptions, concepts, and research. Whether we are speaking in terms of ordinary or emergent complexity, researchers must be aware of their own paradigmatic biases to avoid imposing any interpretive authority onto a truly complex system (Funtowicz & Ravetz, 1994:571, 580-581).

Conclusion

In summary, complexity theory can be described as the unpredictable and creative emergence of new types of complexity that occur in natural, cultural, and societal systems. Such creativity results in complex, ordered systems emerging out of order, disorder, and chaos. Generally, complex, adaptive self-organization takes place in a population of independent agents. Through the exchange and interaction of cooperation and competition, these agents become increasingly interdependent which results in the spontaneous emergence of new and creative structures. The emergence of novel structures not only raises a system's complexity to a higher level, but provides the foundation necessary for the emergence of yet another level of complexity. The agents in adaptive, complex systems maybe constituted by any individual, group, collectivity, or population which makes up, or is organized around a particular system or structure.

Since the Enlightenment, science has attempted to understand, analyze, and explain nature as an ordered, mechanistic environment. The link between modernity, science, and rationality are tightly interwoven as are their influences to the way we perceive nature. Mounting critiques against modernity and the ideals of scientism have begun to deconstruct the authority of science and with it, the concepts of Enlightenment rationality, objectivity, and "progress." Modernity has left behind a legacy that is familiar to most in environmental studies and activism: over consumption, linear progress, unlimited economic growth, managing eco-systems, toxic and carcinogenic pollutants, nuclear technology, global warming, and the depletion of the ozone have all been linked directly or indirectly to modernist ideology. However, with the benefit of history and hindsight, we are increasingly becoming aware that nature (in its broadest sense) is a dynamic, interdependent, non-linear system of ebbs and flows. The emergence of complexity theory and self-organization reflects not only a historical shift in scientific discourse, but a new interpretation of the natural world. It is becoming increasingly evident that whether we are talking about molecules, neurons, species, ecosystems, or societies, there are fundamental similarities in the way they function – exhibiting order, disorder, chaos, reproduction, and change.

With the rise of complexity theory, the scientific premises of foundationalism, universalism, objectivity, certainty, predictability, and order are being challenged and rethought. New theories in the physical and natural sciences are beginning to support the conclusions drawn by feminist, 'Afrocentric', and gay theories that have contested the separation between knowledge, values, and politics. New scientific theories are confirming that we no longer see the world "*as it is*" but in terms of ideological and subjective beliefs that reflect experiences and ethnocentric interests and values which themselves, are the products of a dynamic, complex cultural system (Seidman, 1994:312, 322). Complexity theory offers a model that can address the oppositional contradiction between nature and culture which has existed from pre-Enlightenment to late modernity. Rather than being an opposition, nature, in its totality, incorporates culture and society as part of an interdependent web of interaction. In many ways, complexity theory reaffirms the ideas of Gaia[10] and earlier works of people like Gregory Bateson. However, while the latest theories of complexity and self-organization are an improvement over the ordered nature of the Enlightenment or the biocentric modernist concept of *nature as "use-value,"* scientific constructions of nature themselves are subject to the laws of complexity. Thus, contemporary scientific paradigms will change, evolve, adapt and become more complex and with them, so too will our perceptions of nature.

Notes

1 An example of a *complicated* or simple system verses a complex system can be seen in the Koch Curve Construction. The Koch construction is a process that occurs when self-similar structures go through a feedback loop. For example, if we view an initiator as being a straight line (—)and then introduce a generator, say, a polygonal line (^) that sits on the initiator, and put it through a feedback loop which increases it by the factor of 4 through reproduction, we end up with is a complex pattern like that found on the edge of a snowflake (Peitgen et.al., 1992:91).

2 Emergent complexity posits the dialectical concept of "contradiction" as the key to understanding polar-opposite patterning. In doing so, emergent complexity can integrate seemingly paradoxical concepts such as *creative destruction* into a practical framework (Funtowicz & Ravetz, 1994:569).

3 Matter-energy that is coded is referred to as information, whereas matter-energy that is uncoded is referred to as noise (Wilden, 1980:xix).

4 Here, the term *imaginary* is based on Lacan's questioning of the relations between words and images. Lacan argues that meaning is created through oppositions. Within the realm of the binary, simple oppositions become, what Lacan calls, an "imaginary" reading of the signifier. In this instance, Lacan inverts the Saussurean formula which emphasizes the signifier (a meaningful form) over the signified (the concept that a form evokes). Lacan resists this model arguing that through opposition, the signified can determine the signifier (Ragland-Sullivan, 1991:49).

5 This contrasts sharply with the Christian hierarchy of pre-Enlightenment. Bateson notes that the traditional Christian hierarchy went downwards deductively which started from the superiority of 'man,' to the apes, and so on down to the 'simplest' creatures. As Bateson puts it, "This hierarchy was a set of deductive steps from the most perfect to the most crude or simple. And it was rigid. It was assumed that every species was unchanging" (1973:403). Even in modernity, biocentric hierarchies positioned 'man' at the top as master over all other realms. The following hierarchical inversion and "extinction rule" can be used to re-orientate those hierarchies that were erroneously asserted in the past (Wilden, 1981:333).

6 An example of this can be seen in a variety of human/nature relations. For instance, if global warming continues to increase due to sociocultural forces, then, at some point, cultural and societal behaviours will have to change, learn, evolve, and adapt to an altered biosphere if they are to continue to thrive.

7 The Butterfly Effect, or *sensitive dependence on initial conditions*, was first developed by Lorenz in the 1960's. The Butterfly Effect essentially states that errors and uncertainties multiply which creates a cascade effect. The actual term is derived from the example that if a butterfly stirs the air today in Peking, it can transform into a storm system the next month in New York (Gleick, 1987:8, 20-21).

8 Funtowicz and Ravetz cite the contradiction between reductionism and relativism as the postmodern condition (1994:569).

9 Complexity, if nothing else, is amoral. While initiating change that favours some over others may result in chaotic behaviour and a reordering of the system, it is just as likely that it could result in perpetuating the status-quo. In other words, there is no guarantee that the resulting adaptation of the overall system would be "fair" or just. Nothing, however, is static in a complex system, not even the status-quo – given time and world enough, the status-quo will eventually change.

10 Gaia, named after the Greek earth goddess, was developed by James Lovelock in the 1960's. Simply, Gaia states that the earth works as a single self-sustaining unit which is a living being with consciousness (Wall, 1994:78).

References

Allen, Peter M. (1994) "Coherence, Chaos and Evolution in the Social Context," Futures 26,6: 583-59.

Appignanesi, Richard, Chris Garratt, Ziauddin Sardar & Patrick Curry. (1995) Postmodernism for Beginners. Cambridge, Icon.

Bateson, Gregory. (1973) Steps to an Ecology of Mind. London: Granada.

Bullock, Alan, Oliver Stallybrass, & Stephen Trombley eds. (1988) The Fontana Dictionary of Modern Thought. 2nd ed. London: Fontana.

Ditto, William L. & Louis M. Pecora. (1993) "Mastering Chaos," Scientific America Aug.: 78-84.

Funtowicz, Silvio & Jerome R. Ravetz. (1994) "Emergent Complex Systems," Futures 26,6: 568-582.

Gleick, James. (1987) Chaos: Making a New Science. New York: Penguin.

Hayles, N. Katherine. (1991) "Introduction: Complex Dynamics in Literature and Science," Chaos and Order. N. Katherine Hayles ed. Chicago: U. of Chicago P.

O'Connor, Martin. (1994) "Complexity and Coevolution: Methodology for a Positive Treatment of Indeterminacy." Futures 26, 6: 610-615.

Peitgen, Heinz-Otto, Hartmut Jurgen, & Dietmar Saupe. (1992) Chaos and Fractals: New Frontiers of Science. New York: Springer-Verlag.

Prigogine, Ilya. (1984) Order Out of Chaos: Man's New Dialogue With Nature. New York: Bantam.

Ragland-Sullivan, Ellie. (1991) "The Sexual Masquerade: A Lacanian Theory of Sexual Difference," Lacan and the Subject of Language. Ellie Ragland-Sullivan & Mark Bracher eds. New York: Routledge.

Seidman, Steven. (1994) Contested Knowledge: Social Theory in the Postmodern Era. Cambridge: Blackwell P.

Touraine, Alain. (1995) Critique of Modernity. Oxford: Blackwell.

Waldrop, M. Mitchell. (1992) Complexity: The Emergence at the Edge of Order and Chaos. New York: Touchstone.

Wall, Derek. (1994) Green History: A Reader in Environmental Literature, Philosophy and Politics. London: Routledge.

Wilden, Tony. (1980) System and Structure: Essays in Communication and Exchange. 2nd ed. New York: Tavistock.

Wilden, Tony. "Semiotics as Praxis: Strategy and Tactics," Recherché Sémiotiques/Semiotic Inquiry (RSSI) 1981, 1,1: 1-34.

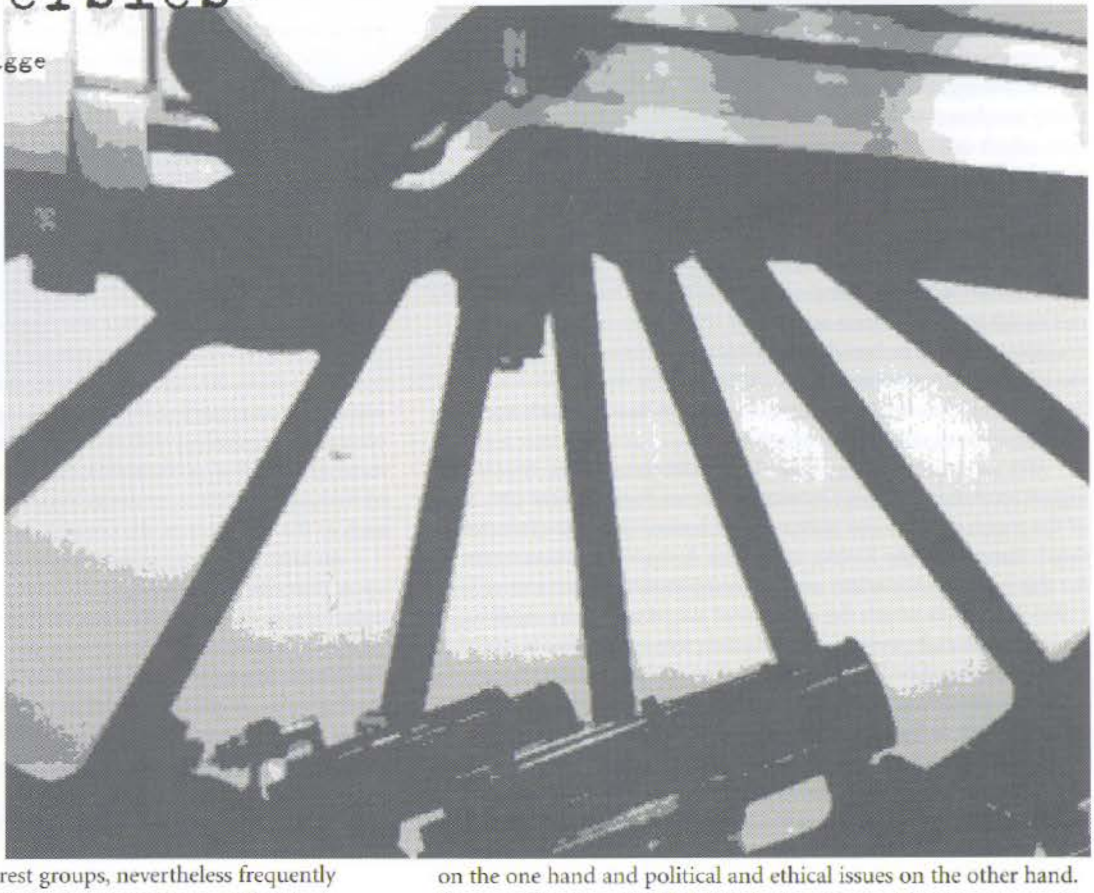
Guy Letts is a graduate student in the Department of Sociology and Anthropology at Simon Fraser University.

Boundary Work in Regulatory Controversies[1]

By Karl-Michael Nigge

Introduction

The regulation of technological risks is an area in which science and policy are generally linked in an inextricable fashion that Wynne aptly describes through the metaphor of the "regulatory jungle" (1992a). It involves a mixture of scientific, political and ethical issues, and due to the presence of scientific uncertainty on a significant scale, even the scientific issues cannot be answered by scientific means alone, but rely on policy considerations for their resolution. Seen from this perspective, controversies over technological risks come as no surprise.



Participants in these controversies, such as scientists, regulators or interest groups, nevertheless frequently attempt to draw clear boundaries between science and policy, which, in reality, do not exist. In general, such attempts to set up fences in the jungle are strategically motivated by the desire to allocate decision making authority in particular ways, or to attach legitimacy to decisions. If an issue can be depicted as science rather than policy, then the respective decision-making authority comes to rest with scientists rather than policy makers, and vice versa. Regardless of who makes decisions, attempts are frequently made to legitimize them by claiming that they are based on science.

In this paper, I will discuss the concept of 'boundary work,' which refers to such strategically motivated definitions of boundaries between science and policy (Gieryn, 1983, 1995; Jasanoff, 1987 and 1990). Underlying the concept of boundary work is a distinction between a substantive role of science in policy or regulatory decision-making reflects the extent to which certain questions relevant in those contexts can be answered by scientific means, such as methods, data and theories, and according to scientific quality standards. In contrast, the notion of a strategic role of science in regulation or policy-making refers to the extent to which certain characteristics, i.e., objectivity, are attributed to science in order to provide legitimization for decisions which are claimed to be based on scientific findings.

Regarding the question of how substantive and strategic uses of science relate to each other in cases where science is brought to bear upon policy or regulatory decision-making, I generally propose that science has a substantive role to play, which is, however, significantly limited due to the presence of scientific uncertainties as well as due to the intricate connection between scientific issues on the one hand and political and ethical issues on the other hand. Compared to its generally limited substantive role, science is nevertheless frequently used as a strategic resource to attach legitimacy and authority to regulatory or policy decisions.

The concept of boundary work, which will be discussed in detail in section 3, is associated with the latter, strategic use of science. Since it can only be understood in relation to the limitations of the substantive role of science in regulatory or policy decision-making, a brief account of the general character of those limitations will first be presented in section 2.

Limitations of the Substantive Role of Science

Limitations in the substantive role of science in regulatory or policy decision making are linked to two main reasons: the existence of scientific uncertainty and the fact that, in many cases, the issues relevant to a decision are not scientific in nature alone, but are tied to political or ethical issues.

Funtowicz and Ravetz (1993) distinguish between three different regimes for the substantive role of science as an input for political or regulatory decision making, based on a model which considers the two dimensions of scientific uncertainty and decision stakes[2]. In the order of rising decision stakes *and* rising uncertainty, they denote these three regimes as *applied science, professional consultancy*, and *post-normal science*. Each of these three regimes is characterized by a particular kind of scientific uncertainty, namely *technical, methodological* and *epistemological* uncertainty.

Technical uncertainty typically involves a statistical spread in measurement data, due to either random fluctuations in the mea-

PHOTO: GUY LETTS

sured physical phenomena themselves or to inaccuracies of the instruments used to measure data or controll a process. In terms of the management of uncertainty, technical uncertainties can be dealt with by well-known statistical techniques of data processing. Technical uncertainties are characteristic for the realm of *applied science* (Funtowicz and Ravetz, 1993:745). Results of applied science, be they some piece of knowledge or some technological artifact constructed on the basis of that knowledge, can typically be expected to be reproducible.

Climbing up the scale of uncertainty, *methodological* uncertainty involves problems with the reliability of theories or information, which can only be managed on the level of personal professional judgment. This situation is typically encountered in situations of "professional consultancy" (Funtowicz and Ravetz, 1993:747) such as medicine or engineering. Professional consultancy generally deals with situations that have a more unique character, i.e., compared to applied science, when reproducibility of results might be more difficult to achieve (Funtowicz and Ravetz, 1993:749). In medicine, for example, this may be because theoretical consensus is lacking about the relavant factors related to the causation of a certain disease, or because an illness might be caused by various factors which are difficult to isolate or control in a specific case.

Yet another, more severe kind of uncertainty on the epistemological level characterizes the scientific issues revolving around "any of the problems of major technological hazards or large-scale pollution" (Funtowicz and Ravetz, 1993:750). A characteristic example for this level of uncertainty are the "completeness uncertainties" (1993:744), from which the widespread use of computer models typically suffers. In this case, only incomplete knowledge is available about the natural or technological system under consideration, such that important parts of the interactions within the system may be completely unknown.

The character of epistemological uncertainties van be illustrated for the case of predictions of global climate change by means of computer models. In this case, completeness uncertainties currently exist, for example, around possible feedback mechanisms, i.e., effects of changes in climate, caused in part by changes in the atmospheric concentration of Carbon-Dioxide (CO2), on the atmospheric CO2 concentration itself. More specifically, increased temperatures generally lead to increased rates of photosynthesis and hence more storage of carbon in plants, which could provide a negative feedback mechanism. On the other hand, carbon stored in soils is released with increasing temperatures, which could lead to a positive feedback. Such possible feedback mechanisms have, however, not yet been fully incorporated into climate models (IPCC 1994:56-57).

In addition to natural systems, "man-made" technological systems can also be sufficiently complex to pose the problem of incompleteness uncertainties for their analysis, e.g., in terms of safety. One of the problems for the consideration of accident probabilities in nuclear power plants, for example, is that, even though the composition of the system (in the sense of hardware) might be known in all details, incompleteness uncertainties with respect to the *pathways of accident scenarios* cannot be excluded (Perrow, 1984).

Scientific uncertainties are thus one factor that limits the substantive role of science for regulatory or policy decisions. However, they do not necessarily render scientific knowledge entirely useless for the purposes of decision-making. An example of how science can provide substantive inputs into policy making, even though those inputs may not be conclusive according to the traditional quality standards of research science, is provided by the case of ozone depletion through chlorofluorocarbons (CFCs).

In 1974, Mario Molina and Sherwood Rowland, two American chemical scientists, published their hypothesis which argued that CFCs, which had been shown to have reached the stratosphere, would destroy the ozone layer[3]. This hypothesis was based on the observation of chemical reactions in the laboratory under conditions that simulated those present in the stratosphere. Based on this hypothesis, the Congress of the United States later authorized the Environmental Protection Agency to ban the use of CFCs as propellants. This policy consensus was based on less than conclusive scientific evidence, given that direct experimental evidence of stratospheric ozone depletion was missing at that time (Weiss, 1993:230).

The missing direct evidence for ozone depletion was later provided by a group of British scientists and NASA, by the discovery of the Antarctic ozone hole, a major factor in bringing about the Montréal Protocol on the phase out of CFCs. At the same time, however, this experimental evidence could not be explained by the theoretical models of the day, such that the *causes* of the ozone hole were not firmly established at the time of the international political agreement on the Montréal Protocol (Weiss, 1993:231-6).

Litfin concludes that in order for scientific knowledge to have a substantive influence on the international negotiations leading to the Montréal Protocol, and its subsequent revisions, it needed to be framed in particular ways, so as to suggest precautionary action – namely, by emphasizing the fact of rising stratospheric CFC concentrations regardless of their ozone destroying effects. Furthermore, the political acceptability of this particular, value laden way of framing scientific knowledge depended on contextual factors, such as the discovery of the ozone hole (1994:187).

In cases where policy or regulatory decision making touches upon scientific issues, such as environmental policy or regulation of technologies, controversies associated with disagreement among various scientific experts frequently emerge. In such controversies, the substantive role of science may be further limited when a smaller or larger part of the debates surround political or ethical issues rather than scientific ones. Examples of such political or ethical issues include questions of equity regarding the societal distribution of risks and benefits, the weighing of risks against benefits, and the allocation of the burden of proof.

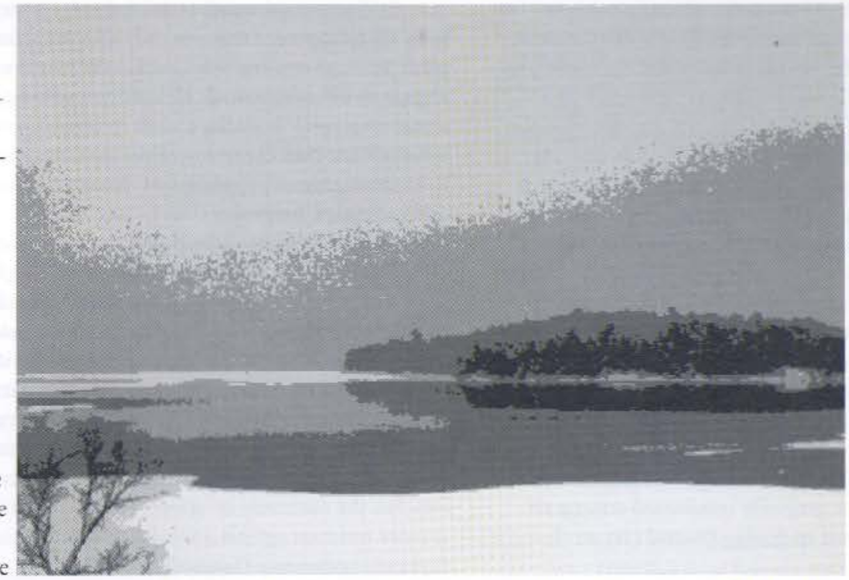
As a result of the limitations of the substantive role of science in providing a basis for policies or regulatory decisions, decision making in fields such as health, safety of technological systems or the environment, in which scientific inputs are often required or desirable, is characterized by a complex mixture of 'facts' and 'values,' such that it is often not clear where science ends and where policy begins.

Science which is brought to bear upon regulation or policy making, due to its close intertwining with policy, assumes characteristics that distinguish it from science in the context of research. Funtowicz and Ravetz (1993), based on their more philosophical analysis, suggest the term 'post-normal science' to emphasize these different characteristics, such as high uncertainties, value-ladenness and decision stakes. In keeping with the sociological and political science literature about science-based regulation, however, I will employ the terms 'mandated science' (Salter, 1988) or 'regulatory science' (Rushefsky, 1986) to distinguish science in the context of regulatory or policy decision-making from 'pure' or 'research science'.

Boundary Work and the Strategic Use of Science

In striking contrast to the above consideration of the limited substantive role that science can play in the resolution of regulatory or policy controversies, science nevertheless plays an enormous strategic role in these controversies. This is generally the case because of the high legitimacy appeal of scientific arguments, or simply because scientific arguments are the only ones which are legally allowed to be put forward, such as in a court case or within certain regulatory proceedings (Wynne, 1980: 183-4; Jasanoff, 1991:44).

In order to attach the legitimacy appeal associated with science to activities which are a complex mixture of scientific and political or ethical considerations, participants in controversies frequently employ rhetorical strategies to define their arguments or activities as belonging to the realm of science. Jasanoff points to the outstanding relevance that rhetorical struggles over the cognitive authority attached to science have in the field of regulatory science, where science and policy inevitably become interwoven, and analyzes such struggles in terms of the concept of "boundary work" (1990:14). Jasanoff's analysis of regulatory controversies in the United States will be discussed in detail later.



The concept of boundary work was introduced by Thomas Gieryn (1983, 1995), who defined boundary work of scientist's as:

> *their attribution of selected characteristics to the institution of science (i.e., to its practitioners, methods, stock of knowledge, values and work organization) for purposes of constructing a social boundary that distinguishes some intellectual activities as "non-science" (1983:782).*

One of the examples which Gieryn uses to illustrate the concept of boundary work is the demarcation of science from religion and mechanical engineering in Victorian England. Demarcating science was supposed to demonstrate the superiority of science, at a time when both religion and engineering presented obstacles to the expansion of scientific authority and resources. Subsequent to the publication of Darwin's *The Origin of the Species* in 1859, the intellectual authority associated with long-standing religious beliefs was an obstacle to the acceptance of scientific explanations of natural phenomena. Mechanical engineers, on the other hand, claimed that technological progress was achieved not due to, but in detachment of, scientific research, such that financial support for science and scientific education would appear without purpose (1983:784-5).

In public speeches and popular writings, John Tyndall, a professor at the Royal Institution in London, distinguished science from religion through characteristics such as the practical usefulness of science in bringing about technological progress, its empirical basis, its underlying skeptical attitude, and the objectivity of scientific knowledge (Gieryn, 1983:785-86). When distinguishing science from mechanical engineering, however, Tyndall attributed to science such elements as systematic experimentation and theoretical orientation and, furthermore, emphasized that the development of scientific knowledge precedes its technical application. Science seeks truth as an end in itself, thereby fostering intellectual discipline and epitomizing human culture. Interestingly, these attributes are in part incompatible with those that were used to characterize science as different from religion (1983:786-7).

Gieryn concludes that, while the rhetorical style of attributing certain characteristics to science in order to demonstrate its superiority over other intellectual activities is common to these and other examples, the specific characteristics attributed to science nevertheless vary according to the obstacles to be overcome and the goals that are pursued (1983:792).

Sheila Jasanoff (1987, 1990), in her analyses of contemporary cases of controversies around the regulation of chemical substances by various federal agencies in the United States, found that boundary work, in the form of definitions of allegedly clear cut boundaries in the gray zones between science and policy, is a rhetorical strategy frequently used in these controversies not only by scientists, but also by regulators and interest groups (1990:14, 236).

Boundary work is often associated with the creation of new linguistic labels or with subtle shifts in the meaning of existing notions (Jasanoff, 1987:199). In the context of regulatory disputes, new labels such as 'science policy', or the complimentary notions of 'risk assessment' and 'risk management' are created to define the boundaries between science and policy in a way favorable to those who use and interpret these labels. For similar purposes, existing notions, such as the term 'peer review', are taken from their familiar contexts and introduced into the realm of regulatory science (Jasanoff, 1987:199).

The notion of 'science policy' was introduced by a legal scholar, Thomas McGarity (1979), and subsequently gained considerable currency in regulatory debates. Science policy denotes issues which require a mixture of scientific and policy deliberations for their resolution. In this sense, the notion of science policy is similar to the term 'trans-science,' which was coined by Alvin Weinberg (1972) to denote questions to which science cannot provide conclusive answers. In contrast to 'trans-science', however, which essentially leaves open who should decide upon such issues, the term 'science policy' has the further connotation that regulatory science is a particular field of policy and hence falls under the decision-making authority of administrators, politicians or the public (Jasanoff, 1987:204-205).

This idea and the way it was implemented by several regulatory agencies in the United States met with considerable criticism from industry, however. In response, methodologies of risk assessment were developed which were supposed to provide a scientific basis for regulatory decisions. In what provides for 'classical' examples of boundary work, the gray zone between science and regulation was frequently divided into the supposedly clear-cut territories of 'risk assessment' and 'risk management'. The former was to be carried out by scientists according to the quality standards of research science and the latter was to be left to regulators or policy makers.

Despite their powerful appeal, these attempts at a separation of science from policy have not gained unanimous support. The contrasting view, which points to the numerous elements of uncertainty and subjective judgment in risk assessment which render most steps of risk assessment a mixture of science and policy, has also gained many supporters. According to that view, risk assessment and risk management cannot be separated (Jasanoff, 1987:209-213)[4].

Somewhat less obviously, demands for 'peer review' in regulatory science can serve a similar purpose of boundary work, appealling to the notion that regulatory science could fulfill the same standards of quality controls as research science, where the concept of 'peer review' was derived. While peer review is problematic in research science, it poses further problems in the context of regulatory science. For example, how are peers selected, and how does the purpose of their review and the structuring of the process affect their review, given the higher decision stakes and the more irreversible character of regulatory decisions (Jasanoff, 1987:218-219)?

The notion of peer review in research science has its origins in the review of scientific papers in order to determine whether they are suitable for publication in a scientific journal. When a paper is submitted to a journal, the editor of the journal typically selects between one and three scientific peers of the author, who review the paper and provide the editor with comments as to whether it is suitable for publication. The ideal of peer review is that it occurs objectively, according to well established, impersonal criteria for the validity of scientific findings (Jasanoff, 1990:63).

Despite the existence of criticisms of peer review in research science, there is broad agreement among scientists that, by and large, the process of peer review of scientific publications works reasonably well (Jasanoff, 1985:21). Even though it is not considered to be fail-safe, peer review is generally considered among scientists as the best possible method of quality control (Jasanoff, 1990:69).

Nevertheless, peer review of scientific publications does have its problems in practice. For example, the selection of the peer reviewers of a scientific paper by journal editors as well as deliberations by the editors themselves can have a significant influence on the outcome of peer review. Editors can often anticipate the kind of comments they will receive on a paper if they select certain scientists as reviewers. Furthermore, journal editors themselves generally have certain discretionary powers in deciding whether or not to publish a paper, giving consideration to aspects such as its novelty, its likely audiences and its political relevance (Jasanoff, 1990:67-68).

Proposals to apply the process of peer review to regulatory science derive their convincing appeal from the underlying assumption that there are no differences between regulatory and research science. As Jasanoff points out, however, regulatory science differs in several aspects from research science in such a way that the problems that exist with peer review even in the case of research science are significantly exacerbated when attempts are made to apply peer review to regulatory science (1990:76-83).

As may be recalled, one difference between research and regulatory science lies in the fact that regulatory science tends to involve higher uncertainties. The issues relevant to decision making are often located at the margins of existing knowledge, driven by what would be desirable to know for the purposes of decision making, rather than by what can be known or suitably investigated on the basis of existing knowledge and methods. The other main difference is that the stakes in regulatory science are typically much higher than in research science. For both reasons, the danger that peer review might lead to biased results is significantly higher in regulatory science than in research science. This problem is compounded by the fact that time plays a critical role in regulatory decisions. While errors in peer reviews of scientific publications may be corrected later on, corrections to regulatory decisions, once taken, are not easily made (1990:79-82).

While variations in the practice of peer review occur in the case of scientific publications (Jasanoff, 1990:64), the above problems raised by the application of peer review to regulatory science convey crucial significance to the question of how such peer review procedures would be organized in detail, such as the selection of the peer reviewers and the openness of the process. Proposals of 'peer review', in the context of regulatory science, appealling to a supposedly well defined meaning and unproblematic character of peer review, represent, instead, instances of boundary work. The gray zone of the intertwining of science and policy in mandated science is simply subsumed under the realm of "pure" science for certain strategic purposes.

In discussing boundary work in regulatory controversies, then, it becomes apparent that not only scientists, but also other participants in these controversies, such as regulators and interest groups, engage in boundary work. Generally speaking, the motivation of actors to employ boundary work in regulatory controversies is to enlarge their own control over the decision making process, and/or to attach legitimacy to claims or decisions. This can be pursued in different ways, however.

As far as regulators or policy makers are concerned, they can either declare a certain range of issues in the gray zone between science and policy as 'science policy' in order to claim that it is ultimately within their responsibility to make decisions regarding those issues. Alternatively, they might also consider it advantageous to declare the same issues as 'science', as long as more or less informal arrangements can be found between regulatory agencies and their scientific advisory bodies. Doing so allows the agencies to effectively retain some influence over these issues, while, at the same time, attaches the authority of 'science' to the outcome in order to make it more resistant against attempts at deconstruction under conditions of controversy (Jasanoff, 1987:212).

As to scientists, their general motivation to engage in boundary work is to preserve the cognitive authority and integrity of science, and to prevent the deconstruction of scientific 'facts' which typically occurs in the more or less adversarial settings of regulatory disputes, from proceeding into the realm of 'pure' science (Jasanoff, 1987:224). Scientists can hereby pursue two fundamentally different strategies. They can, following Weinberg (1972), separate areas of maximum conflict and scientific uncertainty from science itself and attach new labels, such as 'trans-science', to them in order to emphasize their difference from 'pure' science. This strategy, however, leaves it open to whom the authority to make decisions in these gray zones between science and policy should accrue, and according to what procedures these decisions should be made (Jasanoff, 1987:224). This strategy, therefore, minimizes the influence of scientists in regulatory decisions.

Alternatively, scientists can attempt to maximize the influence of science by means of overemphasizing the extent to which scientific consensus actually exists, and thus attempt to 'sell' certain positions as being backed by science which, in reality, emerge from a mixture of scientific and policy considerations (Jasanoff, 1987:225).

In addition to scientists and regulatory agencies, whose motivation for engaging in boundary work is usually an attempt to acquire direct control over the decision making process, other participants in regulatory controversies, who might not have the opportunity for such direct control, such as interest or advocacy groups, also engage in boundary work in order to influence the decision making process according to their own interests. As Jasanoff suggests, since the outcome of a decision making process often depends on the way the authority to make the decision is allocated, it makes sense for them to attempt to take control away from those actors whose decisions are deemed to be less favorable (1987:224).

In the American context, for example, industry tends to see the regulatory agencies such as the Environmental Protection Agency (EPA) as captives of environmental interests. In an attempt to undermine the discretionary power of the agencies, industry has thus argued that the 'scientific' component (risk assessment) should be separated from the 'policy' component (risk management) of regulatory decisions. They also argue that the 'quality' of the 'scientific' component should be assured by means of 'peer review' by scientists external to the agencies. The underlying assumption was that review by external scientists would generally lead to decisions which are more favorable to the interests of industry (Jasanoff, 1987:220, 226).

Calls for peer review in regulatory science are not limited to industry, however. Depending on the circumstances, a call for peer review might as well emerge from public advocacy groups. This happened at one point in the controversy over the carcinogenicity of formaldehyde in the United States, when a decision by John Todhunter, a leading staff member of the EPA, to interpret the experimental data on the carcinogenicity of formaldehyde in a particular way ran counter to the previous practices of the EPA. Notably, the meaning that public interest groups and some politicians attached to 'peer review' in this case was that of internal review by agency staff, as opposed to review by external scientific experts. This internal peer review would likely have resulted in a reversal of Todhunter's decision (Jasanoff, 1987:221).

Moreover, this example illustrates that the rhetorical struggles between actors in a controversy can also take the form of attaching different meanings to the same notion, as opposed to attaching different labels to the same activity. These shifts in meaning of a term are particularly likely to occur for terms that are new in the regulatory arena, such as 'peer review' (Jasanoff, 1987:223).

Summary

For science, which stands in a context of regulatory or policy decision making, two different roles can be distinguished. The substantive role of science, i.e., the extent to which questions relevant to such decisions can be answered by scientific means and according to scientific quality standards, is generally limited due to the existence of scientific uncertainty, and the fact that, in many cases, the relevant issues are not only scientific, but often tied to political or ethical issues. Accordingly, in science based regulatory decision making, science and policy considerations are typically interwoven in a mixture that cannot easily be separated into pure constituents.

In this situation, despite its generally limited substantive role, science nevertheless frequently plays an important strategic role. Labels such as 'risk assessment' or 'peer review' are frequently attached to activities in the gray zone between science and policy in order to suggest that they are purely scientific in character. This is done in order to confer decision making authority to scientists, or in order to attach the "legitimacy" appeal of science to decisions that have been taken by either scientists or regulators. Alternatively, hybrid science/policy activities can also be subsumed under labels such as 'science policy', which place more emphasis on their political character, in order to shift decision making authority towards regulators or policy makers.

Generally speaking, different actors in regulatory controversies, such as scientists, regulators or interest groups, may wish to define boundaries in the gray One between science and policy according to their own interests, in order to enlarge their own control over the decision making process, or at least to take control away from those actors whose decisions are deemed to be less favorable. The concept of boundary work denotes such strategically motivated definitions of the boundaries between science and policy.

Notes

1 This paper is a modified version of chapters 1 and 2 of my Major Paper entitled, "Seismotectonic Boundary Work: A Case Study of Seismic Hazard Assessment in the Regulation of Nuclear Energy in Canada", in which I examine phenomena of boundary work for two cases of regulatory decision making related to an ongoing debate among scientitsts over the assessment of earthquake hazards for the sites of the Pickering and Darlington Nuclear Generating Stations east of Toronto.

2 While Funtowicz and Ravetz largely assume that these two dimensions are independent from each other, Wynne (1992b:116) argues that they are dependent in the sense that all three kinds of uncertainty are always present, and that they are brought up in regulatory or policy controversies to varying degrees depending on the decision stakes and on the particular goals that actors in such controversies pursue. In this sense, Funtowicz and Ravetz assume a more essentialist position regarding the existence of various kinds of scientific uncertainty, while Wynne emphasizes the social construction of uncertainty. A detailed discussion of these arguments is beyond the scope of this section.

3 Rowland and Molina received the Nobel Prize for Chemistry in 1995 for their work on stratospheric ozone depletion.

4 Based on the arguments provided in section 2, I support the latter position.

References

Funtowicz, S.O. and Ravetz, J.R. (1993) "Science for the post-normal age," Futures. September: 739-55.

Gieryn, Th.F. (1983) "Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists," American Sociological Review. 48:781-95.

Gieryn, Th.F. (1995) "Boundaries of Science," in Jasanoff, S. et.al. (ed.) Handbook of Science and Technology Studies. London: Sage Pub., 393-443.

Intergovernmental Panel on Climate Change (IPCC). (1994) Climate Change 1994. Cambridge: Cambridge U.P.

Jasanoff, S. (1985) "Peer Review in the Regulatory Process," Science, Technology & Human Values. 10,3: 20-32.

Jasanoff, S. (1987) "Contested Boundaries in Policy-Relevant Science," Social Studies of Science. 17: 195-230.

Jasanoff, S. (1990) The Fifth Branch: Science Advisors as Policymakers. London: Harvard U.P.

Jasanoff, S. (1991) "Acceptable Evidence in a Pluralistic Society," in Mayo D.G. and Hollander, R.D. (eds.). Acceptable Evidence - Science and Values in Risk Management. New York: Oxford U.P., 29-47.

Litfin, K.T. (1994) Ozone Discourses - Science and Politics in Global Environmental Cooperation. New York: Columbia U.P.

McGarity, T. (1979) "Substantive and Procedural Discretion in Administrative Resolution of Science Policy Questions: Regulating Carcinogens in EPA and OSHA," The Georgetown Law Journal. 67: 729-810.

Perrow, C. (1984) Normal Accidents. New York:Basic Book Inc.

Rushefsky, M. (1986) Making Cancer Policy. New York: SUNY P.

Salter, L. (1988) Mandated Science - Science and Scientists in the Making of Standards. Boston:Kluwer Academic Pub.

Weinberg, A. (1972) "Science and Trans-Science," Minerva. 10, April: 209-222.

Weiss, A. (1993) "Casual Stories, Scientific Information, and the Ozone Depletion Controversy: Intrusive Scenerios in the Policy Process," in Brante, Th. et.al. (eds.). Controversial Science - From Content to Contention. Albany: State University of N.Y. P., 225-240.

Wynne, B. (1980) "Technology, Risk and Participation: On the Social Treatment of Uncertainty," in Conrad, J. (ed.) Society, Technology and Risk Assessment. London, Academic P.

Wynne, B. (1992a) "Carving Out Science (and Politics) in the Regulatory Jungle (Essay Review of Jasanoff, 1990)," Social Studies of Science. 22: 745-758.

Wynne, B. (1992b) "Uncertainty and environmental learning - Reconceiving science and policy in the preventitive paradigm," Global Environmental Change. June: 111-127.

Karl-Michael Nigge is a graduate student in the Faculty of Environmental Studies at York University.

Inside the Hall of Silence
(a biostratigraphically correct poem)

By Joanna Beyers

1. South of Sidney, BC

Time is the sculpted element.
In this moment, opposite the rock
that is James Island
a hawthorn flings its crop of shadow-spines
lightly atop the sand, piercing
in their fall the bits of grass
that flourish despite the salt.
The afternoon is drained of every sound
except for those residing in the silence.
Sandpipers skim the water. Loudest
are the waves the slur against the beach,
the unceasing crickets.

In the early dark the geese fly down
to a shallow spot where
in the morning when the tide is out
herons come to fish.
Nudged by guards into a sleepy column
they will drift sideways across the bay
till dawn.
And inland the high canopy,
the sweet-smelling broom.

2. Once, long after the palm trees

Once, long after the palm trees
abandoned the higher latitudes
there was open woodland
and savanna with horses on them,
deer and camels. Even Rhinos.

Imagine too the crocodiles, loud
flightless birds, bears, cats
The insistent crickets.

3. Go further back

Go further back, take away the birds,
the flowering bushes, sea-lions and bats.
Long embayments tear into the coast
origami fingers that ascend the continent
and reptiles fly over in search of fish
to snatch recklessly on the wing.
Who eats the snails? Starfish
prowl amongst the algae.
Conifers crowd the low hills, wind
pecks at the canopy.

Go further back. All the world is forest
sweltering in the floodplain swamps.
Take away the insects, the steaming
woods, fish and trilobites
turning the muddy ocean floors,
medusas floating.
Microbial mats line the tropical shores,
get drenched sometimes and then
torn down, die &decay, are built
again, settle and decay

and further -
only the hot winds are left
hot over the water
summer storms and fire
in the mountains
cyanide rain
sunlight on the ponds

Some Short Thoughts on Morality, Ecology and Nature

By Laurie Miller

Nature Knows Best, and as Neil Evernden has pointed out perhaps facetiously, Ecology Knows Nature (1992: 8). However, for a number of reasons, these statements have become truisms for many of those who consider themselves environmentalists – "ecology seems to reveal the moral order of being by simultaneously uncovering the *verum, bonum* and *pulchrum* of reality: it suggests not only the truth, but also a moral imperative and even aesthetic perfection" (Sachs, 1992: 32).

At one point in its history, ecology was full of discussions of balance, diversity, climax community and interdependence (Worster, 1994). From this understanding of the way nature "works" there have been many attempts to derive some form of "ecological ethic" based on a belief that human societies should mimic what amounts to a "natural law." From such proponents we learn that human activities which disturb the rule of natural law, which disrupt natural processes or which degrade natural balance are, in effect, unnatural and ought to be replaced by an ethic of Following Nature. Few ideas it seems, have been recycled as often as the belief that the 'Is' of nature must become the 'Ought' of humanity (Worster, 1994).

Of course, some have been determined to demonstrate otherwise, often based on conceptions of nature derived from a radically different version of ecology than that subscribed to by the "followers" of nature. Examples of this are easy to find – Rolston (1979) is convinced we ought not to consider deriving a moral injunction to "follow nature" at least in any imitative sense since

> *nature proceeds with an absolute recklessness that is not only indifferent to life, but results in senseless cruelty which is repugnant to our moral sensibilities. Life is wrested from her creatures by continual struggle, usually soon lost; and those "lucky" few who survive to maturity only face more extended suffering and eventual collapse in disease and death (17).*

Rolston and others believe that nature has condemned us to live by attacking other life: nature is a gory blood bath; all we can be sure of at the hands of nature is calamity.[1] Indeed, if we accept this view of the way nature "is" it seems easy to conclude that nature is not worthy of our moral imitation (in the sense of "following" nature). It is but a short leap to the proposition that nature, rather than requiring our obedience to a harmonious natural law, is suffering from a lack of humanity's controlling, ordering, and moralizing skills: "good men" will attempt to bring order to nature rather than seek order in nature.

This changing interpretation of what nature "is" continues into the present. Although the common public perception of ecology is based on the ideas of community, climax and stability, the modern ecological description of nature is not much different from the version ascribed to by J.S. Mill, based as it is on ideas of ceaseless natural disturbance. That disturbance ecology immediately seems to teach us is that no firm guide to behaviour can be found in nature. If we can no longer determine, either empirically or intuitively what is "healthy"; if what nature is is in constant flux, disturbed, unsteady, chaotic; if change is the only constant in nature, then no moral ought is easily derivable, at least not one of the sort with which we are familiar (Worster, 1994).

(A)moral Science

There is a growing consensus among historians of science (and some scientists themselves) that the way we see nature is merely a reflection of the way we see ourselves. Indeed, the distinction between "us" and "nature" is increasingly apparent as a cultural artifact (Evernden, 1992). What is made clear throughout Worster's (1994) history of ecology, is the extent to which our interpretations of nature are themselves historical. When nature is conceived as the domain of final causes, final forms, a static realm of cooperation and harmony – the harmony of nature reflecting the harmony in the mind of God – then all creatures have their proper place and role in a fixed, natural, society. Indeed society itself was seen as a fixed, static entity, with every person born into his or her appropriate, hierarchical station. But when human society is filled with turmoil, strife, ceaseless change and conflict, the domain of nature becomes a parallel realm of violence, competition, resources, commerce. What was a truism in one age – nature knows best – becomes an ironic indictment of another age's naiveté. The question "can and ought we to follow nature?" changes with each successive alteration in perception of the natural (dis)order.[2]

Although it has been a common ploy of those who hope to "speak for nature" to draw on the authority of ecological science to bolster the moral legitimacy of their claims, the recent history of ecology could be characterized as a continuing effort to strip human "projections" of value, judgment and meaning from a strictly material science (Worster, 1994). Many ecologists have taken great pains to distance their science from those who would seek moral virtue, or at the least scientific support, from its findings.[3] Despite such efforts, many still believe that ecology can interpret moral lessons which are "inherent" in the relations and processes of nature for an eager society.

This aptly serves to illustrate the difficulty inherent in basing a claim about the "proper" way for humans to behave on an understanding of nature provided by ecological science (or what passes for it). Those whose description of nature (as provided by ecology) was that of a force which is reckless, cruel and selfish drew a very different set of precepts about humanity's moral obligations to nature than those whose scientific description of nature involved balance and diversity, or even constant change and disturbance.

What I have been describing is yet another example of what logicians have called the naturalistic fallacy: the idea that because something is true in nature that it ought to be true for "man." It seems as though a further fallacy, if not in logic then at least in strategy, is revealed by reliance on supposed natural truths; when the "is" of nature changes, the moral construct it has been supporting becomes subject to question, as does the authority and reliability of those who constructed that moral imperative (Evernden, 1985). In their reliance on ecological arguments, it may be said that "environmentalists" are engaging in a ruse which perhaps deceives themselves more than it persuades others.

Speaking of Nature

We are told of an era in which value and truth were seen to reside in the mind of God, and through God, as patterns in Nature. What the science of ecology attests to is a history of removing divine properties from the world. The project of science as a whole has been to make the world natural – to remove from our belief, all that is not amenable to material explanation. The supernatural is not the province of science – only that which is explainable – namable – is within its jurisdiction. Through some curious quirks of history best dealt with by others (Worster, 1994; Bronowski, 1978), science has come to be the arbiter of truth for our society, and science deals only with those elements of the world which are accessible to its methods.

What then can we say about attempts to derive natural moral imperatives for society? To what can we refer to as our ultimate standard? What is missing from the philosophers' discussions of fallacies or the activists' debate over strategy is the acknowledgment that arguments such as "Nature Knows Best" are yet another attempt to establish the existence of an external arbiter for action, judgment and morality. Nature fails to fulfill this role precisely because, at the moment ecology determines nature to be other than what we had thought, it is revealed as a construct of our own making.

What I have been leading up to asking is this: do we know what are we talking about when we attempt to "defend nature"? When the ecologists tell us that nature is disordered, violent, or subject to constant and random change, what is contained in the nature of which they speak? Is it the same entity the defenders of Nature are seeking to protect?

As C.S. Lewis noted "we are always conquering nature, for nature is the name for what we have, to some extent, already conquered." In order for nature to serve as an external, independent repository of the *verum, bonum* and *pulchrum* it must be conceived as something beyond human understanding and control. In other words, nature must remain (in at least some respects) supernatural. Yet the entire project of science, and of the science of ecology (despite its remnant Arcadian tendencies) has been to make the world known, to explain the mysterious, to make the fantastic common – to make Nature natural. In order to accomplish this, it has been necessary to redefine our terms. What we find is inherently unexplainable must be removed from the common conception of "nature." Nature (as defined by ecology) is of no moral concern because we have stripped the concept itself of moral interests so that in conquering the material elements (while ignoring emergent, spiritual or moral properties) we conquer only that which we have named. We reduce things to mere nature in order that we may conquer them. Yet it is most often those supernatural qualities, whether described as emergence, self-will, or mystery, that draw many environmentalists into the fray to "save nature." Yet it is precisely these qualities that the science of ecology is distinctly unqualified to interpret for a world so apparently eager for them.

So if the Nature which ecology is describing is mere nature and thus a thing of our own creation, containing nothing which we do not attribute to it, attempts to use such an entity as an external source of moral imperatives for human society becomes a circular proposition. We find in nature only that which we have put there. When Pascal says "there is nothing which we cannot make natural," he is referring to the stripping of supernatural, inexplicable, mysterious elements from the world in order to make it material – amenable to our dissection and control. Once this is the case, there is truly "nothing natural which we do not destroy." Through a small reworking of an "environmentalist's" phrase we learn that perhaps we are hazarding the world by making it natural.

A Divine "Science"

Perhaps we should be asking why some people among us, in this age of relativism, appear so determined to invoke standards of absolute morality in both our relationships with other people and most particularly with nature (here described as the ultimate source of morality: nature knows best, ergo follow nature). It truly appears then, as though the ought has been leading the is. We have found a moral ought in which many appear to believe, and we go seeking some external authority, some external source of value, because we fear our lack of persuasive force without one. Yet that moral value had to come from somewhere. As Pascal said (of God): "you would not seek me had you not found me." Clearly, those people engaged in seeking justification for their moral statement have access to some sort of moral authority in which they devoutly believe. By what name shall we call such an authority? To what can we attribute its force for those who recognize it? Whatever it is, we seem increasingly incapable of mounting a defense of it in the face of a society, and a science, which denies its very existence.

Despite all attempts to the contrary, it appears as though ethical arguments based on ecological science can prove a treacherous prospect for the unwary advocate. Increasingly, it seems as though C.S. Lewis' admonishment may be the most instructive: "an ought must not be dismissed because it cannot produce some is as its credential. If nothing is self-evident, nothing can be proved. Similarly, if nothing is obligatory for its own sake, nothing is obligatory at all" (1947: 53). Moral principles are not things you can reach as conclusions, they are premises. In this way, the solution to the environmental crisis may be a moral one after all. Environmentalists, perhaps, should not be too hasty to dispense with piety.

Notes

1 These admonishments are best summed up by John Stuart Mill in his essay *Nature*: "everything, in short, which the worst men commit either against life or property is perpetrated on a larger scale by natural agents."

2 Of course, the actual history of the relationship between "nature and society" and its interpretation through the science of ecology is much more complicated than this. See Donald Worster's *Nature's Economy* for a more complete rendition.

3 Paul Colinvaux truly is the exemplar of this stance. He writes "Ecology is not the science of pollution...still less is it the science of doom...I write this book in some anger to retort to this literature...I take the opportunity to brand as nonsense tales of destroying the atmosphere, killing lakes and hazarding the world by making it simple." Colinvaux's conclusions regarding the "social implications of ecological knowledge" are that the true model for ecologists is that of Darwin who "did not write of pollution and crisis but of how the world worked" (all quotes taken from *Why Big Fierce Animals are Rare*, 1979).

References

Bronowski. J. (1978) The Origins of Knowledge and Imagination. New Haven: Yale University Press.

Colinvaux, P. (1978) Why Big Fierce Animals are Rare: An Ecologist's Perspective. Princeton, Princeton University Press.

Eiseley, L. (1960) The Firmament of Time. New York, Atheneum Press.

Evernden, N. (1992) The Social Creation of Nature. Baltimore, John Hopkins University Press.

________. (1985) The Natural Alien: Humankind and Environment. Toronto, University of Toronto Press.

Lewis, C.S. (1947) The Abolition of Man. MacMillan Publishing, New York.

Rolston, H. III. (1979) "Can and ought we to follow nature?" Environmental Ethics. v1

Sachs, W. 1992. "Environment" In The Development Dictionary: A Guide to Knowledge as Power. Wolfgang Sachs ed., London, Zed Books Ltd.

Worster, Donald. (1994) Nature's Economy: A History of Ecological Ideas. 2nd ed., Cambridge, University of Cambridge Press.

Laurie Miller is a sometime graduate student in the Faculty of Environmental Studies, York University. She is not entirely certain how much she believes in what she has written. She would like to be a scientist (archaic definition), if they will let her.

PHOTO: GUY LETTS, WATERTON, ALBERTA

BIOLOGY AS RELIGION: Genetic Code as Bible, Scientist as Priest, and Genetic Counseling as the Confessional

By Dean Bavington

Today technical rationales have very much the force and authority of religious doctrine, including the notion that the laity is unfit to question doctrinal content and practice (Franklin, 1990:44).

I recently attended a lecture at Acadia University given by a biologist from McGill University who had been sitting on the Canadian panel looking into reproductive technologies. During the lecture, he continually downplayed the risks associated with reproductive technologies and dismissed all critics of the new technology as bio-luddites. It was his belief that many Canadians were afraid of biotechnology because they had not been properly trained in the field. He repeatedly stated the need for early education in genetics for the Canadian population so that they would be better prepared to make decisions around the emerging biotechnologies. He called for "basic genetic principles" to be taught to children in grade four, ensuring that they would grow up with realistic notions of what the technology could accomplish.

Afterwards, I was stunned by the inability of people in the room (all trained biologists), including myself, to question his perspective. His presentation was delivered in a way which stifled debate and claimed a totalizing objective truth. He was the modern priest, and we were gathered at his feet to express our (blind) faith in human progress as defined by science and technology.

This paper is an attempt to make sense of that presentation and illuminate some of the similarities between biology (specifically biochemistry, genetics, and biotechnology) and religion. In an effort to map the similarities between religion and the biological sciences I will focus on biotechnology and its claims, draw comparisons between the Bible and the Human Genetic Code, the scientist and the priest, and the confessional and the genetic counselor.

The Genetic Code as The Bible

The U.S. Human Genome Project (HGP) officially began in 1988, under the management of the Department of Energy and the National Institutes of Health (Haraway, 1995). The project's aim was to sequence and record all of the nucleotide base pairs located in the DNA molecules of the human genome. The project also aimed to discover the functions of all of the genes (this involved discovering the proteins the genes code for) so that a complete code and functional document of the human genome could be created. This knowledge is compelling at this particular stage of history due to the assumption that the genes are the basic unit of life and that harnessing their information gives humans power over life.

From the information which the HGP produced, scientists claimed that we would know what constitutes human life, what makes us different from other living things, and what causes many disabilities, diseases and illnesses. In many ways the HGP was presented as the Bible of life, the code for describing what makes us human and a final scientific answer to the age old philosophical question, "What is life?"

The code contains many parallels with the Bible as far as what it claims to produce and how its information is presented. For example, literal interpretations of both the genetic code and the Bible claim absolute universal truth about life, nature and humanity. The scientists who are "discovering" the nucleotide sequences present the information they gather as pure truth that emanates from nature, just as literal interpretations of the Bible were presented as truth emanating from God which was recorded by humans inspired directly from divine presence.

However, while both the literalist adherents of the Bible and the genetic code claim universal absolute knowledge, they both contain information that requires interpretation to have meaning. In the case of the Bible, various interpretations have sparked huge controversies and lead to the creation of multiple religious denominations. From this it seems that multiple meanings can be ascribed to the Bible and lead to a variety of different conclusions about nature, life, and humans, and result in a drastically different grounding for moral action.

Similary, the genetic code does not generate truth because it is *syntactic*, meaning that it refers only to relations between signs. It is not *semantic* in that it does not designate something directly or refer directly to something other than another sign (Kay, 1996). In other words, the nucleotide bases that make up the code are self-referential and do not contain meaning in and of themselves. Neither the Bible nor the genetic code operate like an absolute dictionary that can tell us what the world is made of, what it means to be human, or instruct us how to relate to each other or the world.

Derrida has shown us that the production of representations in the lab is a form of text production. Through inventions we produce representations; in other words "We are writing the book of life as we are reading it" (Lily Kay, 1996). According to Derrida words derive meaning from their context. Thus, the context of the HGP will infer meaning onto the "words" of the genetic code. "We cannot simply [objectively] read the book of life, it has no meaning" (Kay, 1996). We are always inscribing a subjective interpretation onto it.

What does life look like when viewed from the perspective of the genetic code? The code shifts our view of reality from a materialist based model to an information/text based view of nature and life. No longer is the cell (a material object) the most important component of life, now the DNA, and more specifically, the information coded in it is the most important part of life and nature. This shift from material based biology to information based biology fits well with Derrida's notion that there is nothing beyond the text. According to the new information/systems view of the world the fundamental structure of both matter and energy (nature and life) is a text. Therefore, the world becomes, as Katherine Hayles has put it, "quite literally a text," a physical embodiment of information (Zimmerman, 1994: 347). From this perspective, life equals an information processing system that is capable of information storage and retrieval as well as its own reproduction. The DNA represents life under this model and increasingly is described using computer information technology metaphors. *DNA becomes the hard drive of the cell* containing the genetic code (the language) that is seen as the underlying foundation of all life.

This new genetic code is presented to us as a savior, as the answer to our most fundamental questions about life and what it means to be human. However, Baudrillard believes "that current fascination with the genetic code and other sign-systems is preparing the way for the 'neocapitalist cybernetic order that aims now at total control'" (Zimmerman, 1994: 354). He believes that the new move toward seeing the world using the information metaphor creates a world of total control where the distinction between the real and the simulation no longer exists. The world becomes a field of free floating syntactic signs, a *simulacra* (Baudrillard, 1981).

Even though the HGP uses the metaphor of the code as its operating principle and it presents the information contained within the DNA as the book of life, the code and the language from which the book is constructed is neither a code nor a language, it is self-referential. The code is just a model that leads us to assume that we can read objective meaning from the information we are gathering through the HGP. The model has been taken as the real thing, as life and nature itself. Whitehead called this the "fallacy of misplaced concreteness" (Gare, 1995: 116). This would seem to suggest that the information which we are gathering from the HGP is of the order of the simulacra which Baudrillard talks about in Simulations (1983). What gets obscured through the passive acceptance of the model is the fact that meaning is constantly being written into the code as it is being discovered. Therefore, the genetic code produced by the HGP appears to present us with objective, universal knowledge about nature and life in a similar fashion that the Bible was once presented as a text from which truth emanated directly from God, unimpeded by the external subjective meanings being ascribed to it.

In order for all of the information from the genetic code to be applied universally within a diversity of social contexts a dogmatic belief in biological determinism is needed. Biological determinism is structured on the belief that society is the *consequence* not the cause of individual properties. The new doctrine of sociobiology/biological determinism is structured to place the emphasis on the genes. Under this model:

Genes Make Individuals -> Individuals make Society ->
Therefore Genes make society. (Lewontin, 1991: 11)

This model prevents any meaningful role for society in the structuring of individuals or the gene and fits neatly with the prevailing classical liberal model of an individual-based society. The deterministic quality of the gene is accepted as fact and a system of linear interaction is proposed that elevates and privileges the information being "discovered" by the genetic scientists who are the new high priests of the genetic code, and claim to read objective information about nature and society from the DNA.

The Scientist As Priest:

While the scientist and the priest create qualitatively different forms of individuals (scientists tend to objectify, priests tend to form new subjects) the scientist has assumed many of the roles of the priest in Western societies. The parallels between the scientist and the priest revolve primarily around their mutual claims to universal knowledge and their hegemony over the production of that knowledge through interpretation. Both scientists and priests interpret their respective texts. Like a priest with a "Bible," the genetic scientist interprets the semantic information of the HGP writes the book of life as s/he discovers it. In either case, the information contained within the "book" is interpreted by the priest/scientist in a way that maintains the authority and hegemony over the interpretation.

The hegemony of interpretive power which the scientists and priests hold allows them to present the information as though it is the *only* truth, and a truth that emanates directly from the respective texts. This power is strengthened through the use of language that is inaccessible to the people to whom the information is presented. Scientists speak in a language that is unknown to non-scientists and they interpret their results for the "lay" public in much the same way the "results" of the Bible were guardedly translated from Greek or Latin and given to parishioners by Priests. The language of science allows a select group of people who are "in the know" to distribute information from scientists to non-scientists, and allows them to interpret the results of the HGP without being fundamentally challenged. The "objective results" of the scientific endeavor can then be presented to the "laity" as if the knowledge emanated from nature itself.

Both scientists and priests call for the early and continuing indoctrination of the "laity." This "education" is presented as being in the best interests of the laity, especially the young, to understand the teachings of the knowledge producer. The "laity" believe the information they are being taught precisely because it is presented as information and not as narratives open to alternative interpretations. In the case of the church, religion was part of the school curriculum up until very recently in most Western societies and in many countries it continues to be a major part of the curriculum. Scientists claim that the knowledge they produce must also be taught to help the young and the old adopt to a changing world. The scientist who spoke at Acadia was adamant about the need to educate the young in order to avoid future "problems" which may arise when the "laity," or public, misunderstood the doctrine of DNA. Priests both past and present have argued for the indoctrination of youth in order to allow for the complete understanding of the teachings of the Bible. The church also called for the continuation of religious teaching throughout adult life. Life-long religious learning was indeed a major part of the doctrine of the church. Today, life-long scientific literacy is being emphasized to enable populations to live with, and to be able to operate in, the information age (Logan, 1995).

The Human Genome Diversity Project: A New Missionary Call?

The Human Genome Diversity Project (HGDP) is a project aimed at the collection of human DNA from a diversity of human populations. It has paid specific attention to Aboriginal DNA sampling and has collected samples "from over 700 groups of indigenous peoples on six continents" (Haraway, 1995: 353).

The history of Western influence over Aboriginal people has one of domination and destruction. Missionaries were often sent hand in hand with colonizers to increase control over Aboriginal people, maintain and foster Western presence, aid in the assimilation process, and to "save" the souls of Aboriginal people for the afterlife. The emphasis of the missionaries was on converting Aboriginal people to Christianity before they died.

Currently, Aboriginal communities are being infiltrated by scientists. Collection scientists from the HGDP collect white-blood cell and check-cell samples from Aboriginal groups to "save" and preserve them, in the form of their DNA, from possible extinction. The scientist has replaced the priest as savior and the emphasis has shifted from the soul to the DNA.

The missionaries believed that the aboriginal people would go to hell if they were not saved, and it was their duty to recruit souls for heaven. Scientists now believe that valuable Aboriginal DNA, with possible future uses, may be lost forever when the people go extinct, and it is their duty to preserve it. They argue that if we lose the aboriginal DNA we would have lost something potentially useful. The wise-use and biodiversity arguments that repeatedly surface in sustainable development literature have therefore surfaced in the HGDP. As Haraway suggests, it is a long term utilitarian calculus that is used to justify the genetic sampling of Aboriginal peoples:

> *Like the vanishing of a rainforest fungus or fern before pharmaceutical companies could survey the species for promising drugs, the vanishing of human gene pools is a blow to techno science. Prompt and thorough genetic collection and banking procedures, as well as preservation of the source of the variation, if possible, are the solution (Haraway, 1994: 353).*

FROM POWER OF DEATH TO POWER OF LIFE

The encroachment of genetic scientists into Aboriginal communities illustrates a shift from concern with, and the control and management of, death to the concern and management of life. According to Foucault, the modern period is marked by an increasing control and regulation of bodies. The human genome project extends this notion of control of bodies to the molecular level.

The outcome of the discipline and control of bodies according to Foucault was the creation of "docile bodies" which were managed bodies (Foucault, 1978).

With the shift of the Sovereign's control over death to the production of "docile bodies," the modern period veered away from the control of death toward the control of life. This was achieved through an explosion of professions dealing with techniques to achieve the subjugation of bodies and the control of populations. Foucault called these practices of biopower (Foucault, 1978: 140).

> *Foucault points out that the discovery of the body as object and instrument of power led to a host of control for the efficient operations of these bodies, whether they were the efficiencies of movement, the measured intervals of the organisation of physical activities, or the careful analysis and timing of tasks the body could perform, usually in unison (Franklin 1990: 59).*

The shift to biopower involved a shift to the production of managed forms of living. The state changed from having the legitimacy and power to kill its citizens to focusing on the creation of individual and social control mechanisms which produced "docile bodies" that would regulate themselves. The lessons of the prison (the panopticon) were applied directly to society and various life "choices" were heavily managed. New forms of sexuality were produced through a flowering of prohibitions which, while telling you how, with whom, where, and when you could have sex, opened up new spaces for sexuality (Foucault, 1978). For Foucault power does not only prohibit it produces.

The power to kill that was vested in the King became transformed into the state's control over the production of ways of living. Under the Sovereign's power of death the confession took on added importance at the time of death. The cleansing of the soul required a full confession upon the death bed and special attention was paid to people who were dying (the reading of the last rites). The genetic confessional, the reading of an individuals genetic code, moves the emphasis to life and pre-life management. The most important time for the genetic confession is before a person is born or even conceived. It is here that the genetic confession, and its associated power matrix, produces its genetic subjects. Just as heaven was the promise of the death-bed sin confession, the genetic confession operates at pre-birth when the possibly "disastrous" random gene mixing can be controlled, ordered, and produced. The power of science rests in the prevention of certain genes from entering the world just as the power of the state to take away life rested in the extermination of life. The power of traditional biopower, control over bodies, was in shaping the social actions of the individual; the genetic confession claims to be able to prevent "deviant and sick" social, physical, and emotional actions from occurring at all and produce genetically normalized individuals.

For the religious, the confession before death is of primary importance, for the genetic laity and their genetic counselors the confession, the reading of the possible gene frequencies, before life is the most important.

Foucault discusses how we have moved from a society of blood (death) to a society of sex (life), and with it, a shift from the sovereign's right to kill, to its management of the normalized lives/bodies of its citizens. I would argue that we are presently in a society of increasing life and pre-life management with its power locus in the gene. The world, nature, and life are now all described to us by scientists. The functional approach to the world, nature and life, that is presented to us by science, deligitimizes non-universalizable individual experience in a strive toward global monoculture. A successive narrowing of the way we see the world, nature, life, and each other accompanies a totalizing scientific world view. Science has replaced Religion as the descriptive force in our society and scientists have replaced the clergy as the authoritative voice of that description.

Genetic Counselor as Confessional:

> *One confesses one's crimes, one's sins, one's thoughts and desires, one's illnesses and troubles, one goes about telling, with the greatest precision, whatever is most difficult to tell. One confesses in public and private, to one's parents, one's educators, one's doctor, to those one loves, one admits to one's self in pleasure and pain , things it would be impossible to tell to anyone else, the things people write books about. One confesses, or is forced to confess (Foucault, 1978: 59).*

Foucault describes a culture of confessors and describes how claims of truth in the West are intricately tied to the confession. The new genetic technologies bring the confessional to a new level, allowing the genes to tell the truth about individuals and even predict their sins before they are committed. Sociobiologists implicate genes in a whole host of conditions which once were believed to be socially influenced or created. Alcoholism, criminal behavior, intelligence, and other factors which are heavily influenced by one's environment, or social situation are seen as being inscribed in the DNA. With the new sociobiology argument all present, past, and future "ills" are described as if they are coded in the genes (Lewontin, 1991). Extending the confession to the genome necessitates individuals whose essence is seen at the genetic level. Individually we must confess our genes' contents and compare them to the standard or norm. Therefore, the genetic confessional involves the production of knowledge and is embedded in a multitude of power relations around the production of this knowledge and its comparison to the norm.

Foucault believed that all knowledge production was tied to relations of power. For Foucault, power and knowledge (power/knowledge) were inseparable and effectively one word (Dreyfus et al., 1983). Foucault wrote extensively about the confession as it related to sex and described how power/knowledge was embedded in its production. In The History of Sexuality (1978: 65) he described five key factors which lead to the incitement to confess and produced knowledge, around sex, in a matrix of power. I believe that these five factors can be applied to the genetic confession.

1 **"Through a clinical codification of inducement to speak. Combining confession with examination"** (Foucault, 1978:65). A similar process occurs with the genetic confession. The medical examination is augmented by the need for a confession of the genes. The "patient" (especially pregnant women or women who are wanting to conceive) is told that a trip to the genetic counsellor would be in her best interest and in the best interest of her baby. Also, many individuals for whom a genetic condition is suspected are encouraged to discover what their genes say. While this process can be helpful for many, it takes place within a matrix of power/knowledge relations that induce people to allow their genes to be read and interpreted in a universal normalizing fashion.

2 **"Through the postulate of a general and diffuse causality"** (Foucault, 1978:65). Having to tell everything and being able to question everything. A huge causal power around sex was created for all kinds of conditions. The genes have replaced sex "with an inexhaustible and polymorphous causal power" (Foucault, 1978: 65) through being presented as the source of all "natural" conditions and human actions.

3 **"Through the principle of latency intrinsic to sexuality"** (Foucault, 1978: 66). The truth about sex needed to be extracted through confession. This was not just because it was difficult to explain or disclose but "because the ways of sex were obscure; it was elusive by nature; its energies and its mechanisms escaped observation, and its causal power was particularly clandestine" (Foucault, 1978:66). All of these properties are now attached to the genetic confessional. The genes require special scientific attention to be read, like sex the information in the genes is "elusive by nature," its information and mechanisms escape observation. You need to run DNA samples out on gel and use electrophoresis, do complicated sequencing and replicating, and analyse the results so that they can

be interpreted and the information understood. In essence, the information which forms the basis of genetic confession is partially clandestine.

4 "Through the method of interpretation" (Foucault, 1978: 66). Truth production not only needed a confessing subject but also an interpreter. In order for truth to be illuminated it must go through the relationship of the confessor and the expert. The genetic counsellor must interpret the results of the patient's DNA in order for the real truth to emerge. It is not enough for the patient just to donate a DNA sample and read the results him/herself, the results would make no sense to him/her. The expert is needed for the truth to emerge and for it to have meaning. A similar situation existed with the priest. Confession had to involve the bringing into discourse all that the person was hiding and needed to say but also included all that the person could not understand without explanation or help. The important point is not that the person does not have the power to understand or prescribe treatment but that truth as produced through the confession needs the relationship between the confessor and the expert.

5 "Through the medicalisation of the effects of confession" (Foucault, 1978:67). Confession was seen as therapeutic. The confession cleared you of your sins and allowed you to begin anew. In this way it was seen as helpful and therapeutic to the individual. The confessional became part of the medical procedure and an important part of the truth production around sex. This now extends to many fields including genetics. Going to see the genetic counsellor is seen as the responsible and healthy thing to do. The information which is gained from the genetic confession is presented as something which will benefit the person, even if no cure for the particular illness is available. In particular women and their bodies, especially when pregnant or thinking of conceiving, are paid "special" attention. The female's trip to the genetic counsellor is not only seen as therapeutic, but as necessary. Due to the genetic confession it is increasingly being seen and presented as irresponsible, for the mother and the baby, to avoid exposing their DNA to analysis.

Life and nature, through the emergence of the HGP, have been transformed into discourse. This allows for all the diversity and complexity of life to be discussed in reductionist, scientific code-talk of genetics. Foucault claims that the process of sex becoming a discourse affected desire displacing, intensifying, reorienting, and modifying it (Foucault, 1978: 23). Foucault's analysis can be applied to the genetic discourse on life. Life itself has been displaced, intensified, reoriented, and modified due to the HGP. This destroys the multiplicity of ways we have seen life and narrows the orientation of how we see society, individuals, nature, and life itself.

Foucault talks about the special power influences that were devoted to women. He claims that women were medicalized and produced as subjects that were to be keep under surveillance. For example, the creation of the medical condition hysteria in women allowed for increasing surveillance and power over their bodies (Foucault, 1978: 120). Under the new reproductive technologies associated with the HGP these powers and surveillance activities are increasing. Biopower over women's bodies, with respect to biotechnology, focuses attention on the female body (especially the pregnant female body) as the locus of increased surveillance, power and control.

Under the HGP, the gene's contents are mapped and explained; and as people are defined as simply a collection of genes, they are made to confess the contents of their DNA. The panopticon which Foucault describes in <u>Discipline and Punish</u> (1979) as a model for social control has increasingly extended its gaze to the molecular level. The panopticon, and the gaze that accompanies it, now covers the social, physical, and molecular realms.

Discipline and Docile Bodies

Foucault describes how the gaze of the controlling and managing technologies increasingly spreads from its origins in the prisons to all aspects of social and individual life. The internalization of panoptical techniques in the individual resulted in self-control and was substantially more efficient than outright torture and public executions. The panoptical gaze now extends to the genetic level, and the drive to confess and therefore open an individuals genes to control and regulation is gaining strength. Individually this panoptical technique expresses itself as increased anxiety about what may lie hidden in our genes. This anxiety, when tied to personal responsibility for individual health, leads to a self imposed genetic panoptical gaze and strengthens the creation of the need for the genetic confession:

> *The human body was entering a machinery of power that explores it, breaks it down and rearranges it. A 'political anatomy' was being born... it defined how one may have a hold over others' bodies, not only so that they may do what one wishes, but so that they may operate as one wishes, with the techniques, the speed and the efficiency that one determines. Thus discipline produces subjected and practised bodies, 'docile' bodies (Foucault, 1979).*

This is exactly what the HGP produces at the genetic level. The "docile body" is now pre-empted by "docile genes." Neil Evernden has observed that this new control and manipulation of DNA destroys "wildness" and domesticates the gene:

> *With the ability to manipulate DNA the situation [of domestication] changes. This is, in effect, the domestication of the gene, the final assault on the wildness of life. The domestication of the gene exterminates wildness at the source and places all life within the domain of human willing (Evernden, 1992: 120).*

Along with the extermination of wildness, "at its source" and the creation of docile genes, the HGP has implications with respect to economic and global capitalism. The project has been implicated in market forces from the beginning with a strong emphasis on the creation of new drugs and therapies which are patentable by multinational drug companies. The HGP is embedded in what Fredric Jameson has called the "cultural logic of late capitalism" (Jameson, 1991).

Foucault discussed how biopower was an important part of the development of capitalism. Industrial capitalism needed bodies to be thought of as machines to be inserted into machinery production (Foucault 1978: 144). The norm was applied to the body for its management and this norm is now being applied to nature for its management:

> *Such a power has to qualify, measure, appraise, and hierarchize, rather than display itself in its murderous splendour; it does not have to draw the line that separates the enemies of the sovereign from his obedient subjects; it effects distributions around the norm (Foucault, 1978: 144).*

A similar process occurs under the HGP. The norm, defined as the natural genetic code, after it has been totally mapped out will play the role of the social normal distribution and will enforce a further move toward the management of life and pre-life as opposed to death. The focal point of this pre-life management will be exerted on women's bodies and will occur in conjunction with reproductive technologies and their associated services.

With the increase in discipline and its application to all social spheres, the greatest punishments/discipline were reserved for sins against purity (i.e.: for what was seen as social pollution). Under the new genetic order will the greatest punishments (i.e.: the denial of birth) be applied to what society views as the new sins against purity, the genetic mutations and "abnormalities?" Will these abnormalities be denied existence because they are no longer "necessary" and we can prevent them? What will this new notion of genetic pollution do to social relations? What will defining purity in genetic terms do to how we view nature, life, and difference? Will the new technologies liberate us and provide choice, as many argue (Hughes, 1996), or will the answers to the genetic counselors probing be predefined by the "systems" in which they operate? It is to these questions that I now turn.

FEEDBACK SYSTEMS AND INFORMATION THEORY

The research which went into the genetic code borrowed heavily from information and communications theory originating in military research labs. Both of these areas of study flow from a systems approach to description. Life defined through the gene is defined as an information system.

> *Gene=information... Information=communication. Genetic and cultural diversity discourses are conflated... [Even] new diseases are interpreted as communications and information transfer pathologies (Eg. AIDS)" (Haraway, 329).*

Therefore an information systems approach has accompanied the HGP and influences not only the way we see nature and life but also has implications for the way we conceive of social relations such as freedom.

When talking about liberty and freedom of choice, the promoters of the new technology claim that it will greatly increase both (Hughes, 1996). However, the discourse around the HGP is information discourse and therefore it inherently blocks out legitimate free choice. A systems approach to choice provides an illusion of choice it replaces reciprocity, which forms the backbone of freedom in a democracy, with feedback. Within our everyday language feedback and reciprocity are increasingly interchanged and are used as if they hold the same meaning. Increasingly feedback is considered the term to describe how we interact because it fits with systems theory and is a plastic word (Uwe Poerksen, 1996) that can be applied to a variety of processes. However, when applied to freedom, feedback and reciprocity illuminate radically different perspectives.

When life is referred to as an information system, under the discourse of the HGP the idea of feedback loops is applied to choice. It is assumed that given "informed consent" adults will be able to make rational free choices about what to do with the new biotechnologies. However, I would argue that choice will be restricted to certain narrow parameters which will fit binary predesignated yes/no responses. Legitimate and influential freedom, in practice, comes when individuals can design the questions and not be reduced to giving yes or no answers to them. Information systems language masks the difference between feedback and reciprocity.

> *Reciprocity is not feedback. Feedback is a particular technique of systems adjustment. It is designed to improve a specific performance. The performance need not be mechanical or carried out by devices, but the purpose of feedback is to make the thing work. Feedback exists within a given design, in can improve performance but not alter the thrust or the design (Franklin, 1991: 49).*

Reciprocity, as opposed to feedback, is situationally based. It is a response to a given context, it is neither designed into the system or is it predictable. Reciprocal discussions around choice allow for freedom of choice. The HGP and the description of human systems as feedback mechanisms presupposes a certain design and assumes that it is fixed, it allows for no reciprocity or real choice. Once the "normal" is defined in relation to the human genetic code going against the norm will be seen as an irrational act that is not within the parameters of the system. Due to systems models being applied to human choices, discussions around emerging biotechnologies will be restricted to feedback mechanisms that are implicit in the discourse around the genetic code. These mechanisms run the risk of leading to a restriction of choice while being presented as new technologies of liberation. This is a similar pattern that many technologies follow, claiming to liberate but then enslaving (Franklin, 1990). This is not due to the inherent control intrinsically a part of the technology, but grows out of the necessary discursive framework in which the technology is conceived, designed and presented to the society (Franklin, 1990).

Systems of Production are at the heart of the HGP and its associated new reproductive technologies. This approach carries with it a set of values and assumptions that direct how the technology is utilized and why the technologies were developed in the first place. As Ursula Franklin says:

> *The close monitoring of the fetus and some of the invasive prenatal technologies can only be considered quality control methods with the accompanying rejection of substandard products (Franklin, 1991).*

Systems of production also alter the way we see nature. "Nature is [seen as] a genetic engineer that continually exchanges, modifies, and invents new genes across various barriers" (Haraway, 1995: 331). Once nature is conceived of as an engineer various human engineering interventions can easily be justified. After all, if a beaver creates "dams" that enable forest secession what is to stop humans from mimicking the beavers behavior in the name of nature? A human term, "damming" is projected onto nature and then we utilize the projection as justification for human actions. When engineering metaphors are applied to DNA and nature is seen as the modifier, human impulses to dominate, control, and regulate at the genetic level can be justified through appeals to mimic "mother" nature the engineer.

This circular play with signs negates the possibility of essence, or the real, and becomes what Baudrillard calls the simulacra. The active nature of the systems production model, the fact that "in nature" there is continual modification and invention, fits well with human interventionist managerial approaches to nature.

CALLS FOR GENETIC SERVICE

Accompanying any new technology and/or service are calls for its universal implementation (McKnight, 1995). Ivan Illich and John McKnight have written on the role of the expert manager in communities and how experts and their services tend to undermine and disable communities rather than help them. They also tend to remove autonomy and choice while presenting themselves as liberation tools. When genes become inserted into dominant discourse and implicated in fields of power they become managed. Foucault described how the discourse around sex made it something that was not simply condemned or tolerated but managed, inserted into systems of utility, regulated for the greater good of all, and made to function according to an optimum (Foucault, 1978). Sex was not only something to be judged but also to be administered. The same can be said of nature and life under the human genome project.

Sex became an object for management procedures and analytical discourses and therefore became a political issue (Foucault, 1978: 24). A similar process is occurring with the HGP. The gene/DNA is being inserted into management and analytical discourses. This will lead for calls for the expert, the scientist and genetic counselor, who will administer genetic "services." McKnight talks about the increasing service economy and its increasing reliance on need. In the West, as we shift away from material commodity production toward service production we increasingly ***need*** need to keep the economy growing. The HGP will open up another frontier for needs management and servicing at the pre-zygote, zygote, natal, post-natal, child, and adult stages of life. Life, as defined by the HGP, will therefore becomes a quarry of needs which can be mined to feed the service based economy.

McKnight discusses how services are first presented to communities, second a need is created for them, and finally the people themselves in the community demand the services through the framing of the services as universal human rights. Liberation is seen as being tied to the expert service that suddenly can not be done without because the structures in the community that existed before have been replaced by the "new" service. In this sense the service based economy is a "sustainable" growth economy that undermines that which is claims to "help," thereby ensuring its future growth.

Foucault describes this process with respect to sexuality saying that the irony of the deployment of sexuality is that it makes us believe that our "liberation" is in the balance. We are told that sexual liberation will free us, and we are urged to get in touch with our sexuality and discuss it more and more. This process of turning sex into discourse and medicalizing it changes it, and adds it to the management sphere of influence. A similar process is happening with respect to life. Through the definition of life as the genetic code and by presenting genetic technology as a form of liberation, from genetic "defects," and the randomness and unpredictability of "genetic" illness, we expose life increasingly to the management realm.

Ironically this process fits a positive feedback-loop where liberation is presented to us as something that is tied to a particular technology which undermines liberty (Foucault, 1978: 159). Real choice, meaning the right to frame the type of questions we want to ask about life and nature, is stifled and we are presented with a binary feedback loop choice, yes or no. Freedom through relationships of reciprocity are replaced by system of feedback. The HGP claims to be freeing us from nature, randomness, danger, and risk and claims to be opening up possibilities when in fact it is limiting our choices and narrowing our experiences of life.

Technologies are not inserted into societies equally and their effects on individuals vary. Foucault describes how the emerging technology of psychoanalysis allowed the urban rich, through confession, to express their incestuous desire in discourse while at the same time, in rural areas, a systemic campaign was organised against incestuous practices. (Foucault, 1978). This campaign legitimised removing "endangered" children who might be exposed to incest. Will the new genetic technologies remove the right of the poor to start a life? Will genetic technology exhibit its power over pre-life, thereby completing the modernist project of complete and total control over life rather than death? In the case of reproductive technologies, it is only the wealthy who have access to them. With increasing infertility rates, there could conceivably be a time where the poor are banned from having children (except as baby factories) simply through financial barriers. This is already evident in certain parts of the world including the United States.

This paints a dismal picture of the future under the genetic code. However, within Foucault and Illich there are glimmers of hope. Foucault's analysis of power relations always leaves room for resistance. Illich hints at one way this resistance can be realized. He points to the fact that all mangers and experts require the compliance of their clients. Without the compliance and the refusal to be labelled as a deficient other, but as a competent and value producing other, the role for the expert is minimised if not eradicated. The challenge in the face of genetic technologies will be to hang on to a diversity of notions of life that debunk the dominant metaphor of life as a code. If this diversity of metaphors can be fostered and encouraged the impact of genetic technologies can be resisted.

Conclusion

It seems to me that with respect to the HGP and it's associated technologies, life and pre-life management delivers control but claims liberation and freedom. The irony is that the increased management of nature and humans is being seen and offered as our liberation, while in the process we are changing ourselves. When we increasingly strip the world down to individual properties, what John Ralston Saul (1995) calls the dictatorship of reason, we reduce the diversity of ways of knowing the world and reduce the possibility for meaning in the world (Lewis, 1943). From the perspective of the modern biological sciences which have long suffered physics envy the HGP seems to offer a final solution and passkey into the physics club. Under this model of the world Dawkin's "selfish gene" would seem to represent an unstoppable challenge to biological science and a ground to prove the management capabilities of the new biotechnologies. The domestication of "the selfish gene" will, as Neil Evernden has pointed out, exterminate wildness at its source.

I began this essay to try to make sense of the presentation I attended at Acadia. The use of the analogy of science to religion was used to illuminate some of the major similarities in the way knowledge is presented, produced, and implicated. My hope is to raise questions concerning the emerging genetic technologies, and debunk the myth that all critics of the new technologies are simply bio-luddites.

Management claims freedom and liberation but delivers increased control over humans and nature. If we can avoid the temptation to domesticate Richard Dawkin's strawman "the selfish gene" perhaps we can resist the destruction of the diversity of meanings of, and ways of seeing, life.

References

Baudrillard, J. (1981) For a Critique of the Political Economy of the Sign. St. Louis: Telos Press.

Baudrillard, J. (1983) Simulations. New York: Semiotext(e).

Evernden, N. (1992) The Social Creation of Nature. Baltimore: The Johns Hopkins University Press.

Foucault, M. (1978). The History of Sexuality: An Introduction, Vol. I. New York: Vintage Books.

Foucault, M. (1979) Discipline and Punish: The Birth of the Prison. New York: Vintage Books.

Gare, A. (1995) Postmodernism and the Environmental Crisis. New York: Routledge.

Franklin, U. 1990. The Real World of Technology. Concord, Ontario: Anansi Press Ltd.

Haraway, D. (1995) "Universal Donors in a Vampire Culture: It's All in the Family: Biological Kinship Categories in the Twentieth-Century United States" Uncommon Ground: Toward Reinventing Nature. Ed. William Cronon. New York: W.W Natan and Co.

Dreyfus, H. and Rabinow, P. (1983) Michel Foucault: Beyond Structuralism and Hermenutics. Chicago: University of Chicago Press.

Hughes, J. (1996) Embracing Change with All Four Arms: A Post-Humanist Defense of Genetic Engineering. Chicago: McLean Center for Clinical Medical Ethics, Department of Medicine, University of Chicago.

Illich, I. (1977) Toward a History of Needs. Berkely: Heyday Books.

Jameson, F. (1991) Postmodernism and the Cultural Logic of Late Capitalism. London: VERSO.

Lewis, C.S. (1978) The Abolition of Man. London: Fount Paperbacks.

Kay, L. (1996) A Book of Life? How a Genetic Code Became a Language. Toronto: Seminar Series on Knowledge in the Age of Information. York University.

Lewontin, R.C. (1991) Biology as Ideology: The Doctrine of DNA. Concord, Ontario: Anansi Press Ltd.

Logan, B. (1995) The Fifth Language. Toronto: Stoddart.

McKnight, J. (1995) Careless Society: Community and It's Counterfeits. New York: BasicBooks Ltd

Poerksen, Uwe (1996) "Plastic Words," Toronto: On Ideas Program hosted by CBC Radio.

Zimmerman, M. (1994) Contesting the Earth's Future: Radical Ecology and Postmodernity. Berkely: University of California Press.

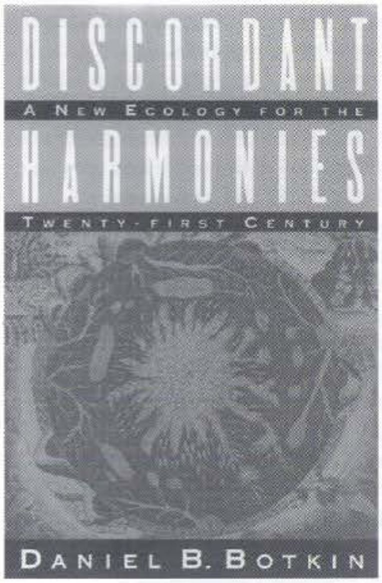
Dean Bavington is in the Master's program in Environmental Studies at York University, focusing on environmental ethics. He wishes to thank Nick Garside, Cate Sandilands, and Neil Evernden for their help in the formation of the ideas presented in this paper.

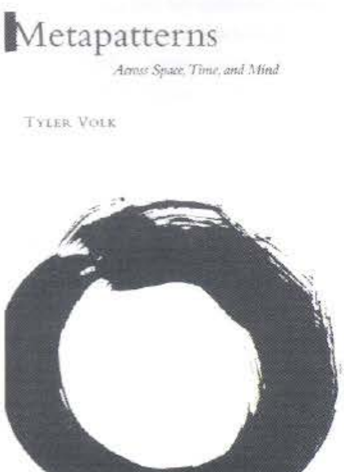
Review Essay

Wild Knowledge: Science, Language, and Social Life in a Fragile Environment, Will Wright, Minnesota, 1992.

Discordant Harmonies: A New Ecology for the Twenty-First Century, Daniel B. Botkin, Oxford, 1990.

Metapatterns: Across Space, Time, and Mind, Tyler Volk, Columbia, 1995.





Science and The Paradox of Harmony

By Luke Wallin

One night not long ago I attended a meeting of the faculty and Ph.D. students in MIT's Planning Department. One professor spoke of the impressive ability of his colleagues to generate and publish case studies. But the problem is, he said, despite the apparent success of each study, the general situation of society and ecology grows steadily worse.

We might think of the elegance of atomic theory, and the horror of actual atomic blasts for people and ecosystems. Or we could look at the harmonies within ethnographies, and their uses by intelligence services or the marketing divisions of corporations. This paradox of harmony – its production by scientists in the very teeth of a deteriorating planet – is usually dismissed as too obvious for rigorous concern. After all, aren't we simply talking about the difference between theory and practice? Or between explanation and action? What would it mean to *theorize* the relationship between harmony within science and discord outside?

Every experiment is a universe: control groups provide order, dependent variables offer novel but measurable surprise. From within each problem, hypothesis, and attempt at solution, an image of serenity radiates outward. Kuhn called events and their descriptions within experimental frameworks 'normal science,' to contrast them with revolutionary changes at higher levels of theory. This 'normality,' multiplied by every experiment in every lab, depicted in media as 'science,' suggests an entire culture of calm control. Every subspecialty has its jargon, its long apprenticeship, its rituals of grantmaking. Young scientists grasp the code: cage-rattlers need not enter here. The culture of science requires a judicial temperament as condition of entry, as passkey to play the game of imagining new 'normal' harmonies, then announcing them in due course to the nonscientific world. Read through a copy of *Nature, Scientific American, The American Scientist, The Sciences, or Discover* magazine, and you come away with the impression of a vast, controlling empire of scientists at work, each one filled with restrained joy for a particular focus, and the collective whole pursuing benignly an abstract 'truth.'

What is really represented is the dominant culture of modernity, which bankrolls science and projects hierarchy and order onto its official domain of 'the facts' which represent 'reality.' Science is held by its sophisticated interpreters, such as philosopher Karl Popper, to be about observation and measurement – never 'ultimate' entities – yet the public still believes scientists achieve privileged access to the world itself. This realism extends beyond the entities taken as real, to the descriptive character of the harmonies implicit in science and science reporting.

Within this paradox, scientists are able to concentrate on their individual niches, *imagining* an orderly universe of discourse for their objects of study, preserving the social benefits of their conservative institutions. In turn, the fruits of their labors are gathered and used by others to create social and physical disharmonies on a planetary scale.

The three authors discussed below attempt to rethink the concept of harmony in relation to science. By focusing on notions of sustainable reason (Wright), metaphors of nature (Botkin), and metapatterns across space, time, and mind (Volk), each offers a path through the paradox of harmony, and hence toward a scientific practice which no longer contributes to a discordant world.

SUSTAINABLE REASON

Will Wright, a sociologist and mathematician, observes in *Wild Knowledge* that, 'As a mathematician I was struck by how the appearance of rational coherence can be derived from essentially arbitrary foundations, and by how a formal mathematical structure would always appear as a set of arbitrary assumptions to the mathematician and as a basis for natural explanations to the physicist.' (p. xiii)

Wright argues that nature (imagined as a realm of objective facts which we can know) and humans (as described by psychology and economics) are incoherent notions which are destroying the planet. This incoherence, this lack of sustainability and ecological reason, derives from conceptual mistakes in our worldview; the beliefs that suggest we can achieve privileged access to objective reality, and that we are discrete, Hobbesian individuals.

Against privileged access views, Wright draws on well-established anti-foundationalism arguments from a broad range of thinkers, from Thomas Kuhn to Richard Rorty. He contrasts appropriately humble claims to knowledge with religion's insistence on absolute truth. The latter embodies a kind of hubris, and blocks social criticism of knowledge claims.

This point applies to the hubris of physics, economics, and psychology as well. For example, take the famous problem of facts and values. If one accepts physics' descriptions of the world as a realm of 'objective facts,' there is no place for values. Active human agents, minds, and their values, are left out of the 'lawful' world, and so ethical and esthetic disputes reduced to shouting matches. Relativisms, such as emotivism, leave the way clear for bulldozers and chainsaws. Furthermore, this simple-minded and false account of moral experience often cloaks itself in the hubris of scientific authority.

The bulldozers and chainsaws, the burning of rainforests, and legions of other environmental and social problems, are an important part of Wright's argument. In addition to philosophical points, he invokes commonsense against the destructiveness of 'technical reason.' What is needed is 'wild knowledge,' meaning knowledge open to social critique, and 'sustainable reason,' which does not destroy.

The corollary to the 'external world' of facts is the modern individual, known by 'behavioral science' as a bundle of desires driven by 'natural law.' (Usually, he says, the law of consumer advertising.) For a critique of this notion, Wright relies on McPherson's *The Political Theory of Possessive Individualism.* He suggests that, despite the compelling technical arguments (and the viewpoint of common sense) that something must be radically wrong with our 'official' scientific and cultural worldview, people still embrace it as their dominant worldview. While many argue that this theoretical 'crisis of the foundations of knowledge' doesn't matter, because science offers the 'inevitable' benefits technology, on a planetary and intergenerational scale, there are no benefits. Technology and technical reason are destroying human life and its ecological base.

Most importantly, Wright suggests, we must recognize that language has a social dimension, and should be open to social critique. His model is health vs. medicine. Medicine is a technical science which, while holding powerful cultural authority, is open to critique from the common sense viewpoint of health. Ordinary people are often competent to challenge medical authority when health falters. Claims about IUDs, mastectomies, silicone implants, etc., must be evaluated by their effects. In the same way, 'official' claims about environmental risk must be judged by their effects (not by techno- 'risk assessors').

Wright attempts to spell out an application of these pragmatic ideas via a key concept: the priority of language over individual humans. We can only act as humans through speaking a language. Language, therefore, is logically (not temporally) prior to the existence of any individual human being. A language which is sustainable and ecological will contain the possibility of its own existence, its own continuation. Thus a social self-reference is necessary for collective health.

Finally, Wright moves to the books of Kenneth Burke on rhetoric, for an account of how language works in its socially sustainable dimension. All language is classificatory, positing known vs. unknown terms, the familiar vs. 'the other.' Otherness is a linguistic necessity, and the tension to resolve it is a necessary condition of living language speakers. Particular classificatory systems will always be somewhat conventional, and none will ever hold a privileged access title to truth and certainty. But some such system will be necessary for talk to continue. Otherness, at its conceptual base, is wildness. The effort by active speakers to articulate and thus *tame* otherness is a necessary condition of continued language use and social life. Wright's pragmatic critique of realist conceptual holdovers leads toward a new understanding of the meaning of pragmatism for our time. And this meaning lies in the effort to develop a sustainable social and ecological rhetoric that moves beyond the dominant root metaphors of science and technology.

METAPHORS OF NATURE

Daniel B. Botkin's *Discordant Harmonies* could be read as an application of Wright's approach to the science of Ecology. In detailed discussions drawn from a professional lifetime, Botkin shows precisely how harmonious but false theories and the 'normal science' generated from them produced disastrous policies.

By pointing to ice sheets, volcanoes, and other disruptions of living systems, he argues there is no 'natural' mature state of nature which we can identify, value, and expect. One of his most disturbing and interesting themes is a critique of the normative uses made of the concepts of 'ecological succession' and 'climax forest.'

Botkin approaches this through discussion of two foundational myths of Western culture. Each derives from an ancient lineage, and claims many supporters today. Yet each myth is false. The first often serves as the broadest philosophical assumption of developers; it is the belief that *there is a balance of nature which humans cannot seriously undo, no matter what mischief we enact.* The second, often an article of deep faith for conservationists, is that *there is a balance of nature which humans can fatally disturb – and perhaps already have.* Both parties believe in *some* concept of nature in balance. However, Botkin outlines how ecologists have recently come to recognize the pervasiveness of change in nature:

> *Until the last few years, the predominant theories in ecology either presumed or had as a necessary consequence a very strict concept of a highly structured, ordered, and regulated, steady-state ecological system. Scientists know now that this view is wrong at local and regional levels – whether for the condor and the whooping crane, or for the farm and the forest woodlot – that is, at the levels of populations and ecosystems. Change now appears to be intrinsic and natural at many scales of time and space in the biosphere. (p.9)*

He discusses Tsavo, a 5,000 square mile national park in Kenya. When it became a park in 1948 its landscape was dry and flat, heavily forested but devoid of many large animals which had been killed around the turn of the century. David Sheldrick, its first warden, devoted years to building up the population of elephants and other species. He built thousands of miles of roads for tourist access, brought in water, and carried out an aggressive campaign against poachers. By 1959 he'd had too much success: the elephants were knocking down trees and other vegetation, and turning the park into a 'lunar landscape.'

Scientists were called in to study the situation. They recommended that 3,000 elephants be shot to keep the population within its food supply. Sheldrick nearly agreed, then reversed himself and fell back on his faith in the old balance of nature idea. He said that

> *the conservation policy for Tsavo should be directed towards the attainment of a natural ecological climax, and...our participation towards this aim should be restricted to such measures as the control of fires, poaching, and other forms of human interference.(p. 10-11)*

Botkin comments,

> *At that time, the phrase 'natural ecological climax' was taken to mean nature in a mature condition, the result of a long series of stages that occurs after a catastrophic clearing of the landscape and, once attained, persists indefinitely without change. (p.17)*

The park's trustees sided with Sheldrick, and the result was that the elephant population reached and surpassed the points characterized as crisis, overshoot, crash, and die-off. The once-green park became a desertified and nearly lifeless wreck. This result showed decisively that, at least at 5,000 square mile scale in that place and time, change and not stability was intrinsic to the ecological community.

These examples show the fallacy of trusting that nature's balance will 'take care of itself.' But other examples just as readily show that human activity can upset nature at various scales. One could point to the many extinctions wrought by human 'development' – irreversible errors.

And yet, a conservationist cannot help but fear that, if change is admitted as intrinsic to nature, as 'natural,' then one can never argue against the changes developers want to make. Botkin says we must distinguish between desirable and undesirable *rates* of change. And we must recognize our responsibility to choose the ecosystems we want – and not simply pretend God or Nature has already created those which are ethically 'good.'

Aldo Leopold, in his 1948 *A Sand County Almanac*, called for a 'land ethic,' which would value a 'state of harmony between men and land.' Botkin agrees, but wants to update the kind of knowledge needed to achieve harmony, and to clarify the concept of a *new* harmony. Whereas Leopold had repeated the ideas of 'forest succession' and 'climax forest' as natural goods, Botkin shows how various states of forests and other ecosystems change in response to unpredictable patterns. To claim 'goodness' for a particular pattern of ecosystem stability, then, would require more than reliance on the old 'balance of nature' idea. Other criteria, such as our preference for historical periods (such as the way forests looked to early European explorers), or our desire to protect a single endangered species at the expense of others, must be admitted into the debate.

What can we know of the larger, chaotic patterns that give rise to the temporary, local harmonies we call ecosystems? Botkin briefly discusses the philosophical issues of chaos and order, but rather than take a position on ultimate issues of determinism, randomness, and free will, he uses the language of chaos theory as a metaphor for what ecologists observe.

> *The philosophical issues are more difficult for the physicists than for the ecologists. In the forests of Isle Royale, infrequent severe storms are an important cause of the death of trees. From a tree's point of view, if one can use that expression, the occurrence of such a storm is unpredictable. The effect of the storm on the tree's survival and on the evolution and adaptation of trees in a forest is a result of events that cannot be distinguished, at the level of response open to trees and other living things, from a truly probabilistic event. ...Nature as perceived by living things is a nature of chance. (p.124)*

To understand the larger pattern of discord within which, from time to time, living systems of increasing complexity emerge, is not to fall into a hopeless relativism about ecological values. Rather, it is to take greater responsibility (1) for our own conceptualizations of nature, through working to grasp the history of our metaphor systems, and (2) for our management decisions about areas of nature. At the level of theory, we must move beyond such master metaphors as NATURE IS DIVINE ORDER, NATURE IS AN ORGANIC CREATURE, AND NATURE IS A GREAT MACHINE. After splendid historical accounts of these ideas, Botkin proceeds to discuss new metaphors drawn from computer hardware and software, and to show how we can appreciate their power in mirroring the complexity we now recognize, without falling under their spell and elevating them to the status of reified myths. Ultimately, we must accept a humble, open, and pragmatic attitude toward natural systems. Never again should anyone assume the hubris of 'privileged access' certainty. Botkin concludes with a call for massive investment in biological science, and the introduction of interdisciplinary ecological studies into educational programs on a far wider scale. His solutions may be a bit too institutional and apolitical, but readers can adapt his important ideas to their own opportunities.

METAPATTERNS ACROSS SPACE, TIME, AND MIND

Tyler Volk is an Earth Systems scientist at NYU. He has worked as a computer modeller for NASA, specializing in the ocean's carbon cycles, and made original contributions to a variety of subjects from growing gardens in space to the extinction of dinosaurs. In this book he draws upon his undergraduate degree in architecture, and applies structural thinking to every scale known on earth. If Wright's book offers a pragmatic challenge to technical reason, and Botkin's work applies such a challenge to Ecology, Volk's ideas generalize Wright's perspective even further. By seeking out 'metapatterns' that connect spatial and temporal structures at vastly different scales, and collecting thousands of instances of these 'crossing' into metaphorical and cultural space, Volk provides a creative way of addressing the paradox of harmony.

The term 'metapatterns' comes from Gregory Bateson, with whom Volk studied. Bateson would pull a crab from a bag, and ask students how the two claw-equipped limbs shared a common anatomy, despite differences in pincer size. How do they compare with lobsters? And how does this generalized anthropod pattern compare with the mammalian pattern, drawn from a parallel exercise with a human and a horse? Bateson suggested 'discarding magnitudes in favor of shapes, patterns, and relations.' He is remembered for goading students and readers to search for 'the pattern that connects.'

Volk has taken off from this idea and, after twenty-odd years of thinking about it, produced a kind of comparative anatomy of the biosphere itself. Chapters 1-6 catalogue and meditate on universal patterns in space, while chapters 7-10 do the same for time. But this is no realist grabbag of ontological 'parts'; Volk constantly cuts back and forth between nature and culture, to show the profound ways our imaginations mirror and project metapatterns.

This is the book's beginning:

> *We began life as simple, floating spheres. As eggs we popped from follicles in ovaries of mothers-to-be. Fertilized by sperm in fallopian tubes, dividing again and again, our spheres persisted. But when we nestled and flattened into womb's wall, and, later, groped with arms and kicked with legs, an interplay between the sphere and its contrary began. This interplay forever follows us: by day we walk as upright sticks; at night we curl into fetal balls.*

From the electrons within hydrogen atoms to the sun and moon, to the human skull and to an autumn grape, sphericity emerges as a principle of geology, biology, and, metaphorically, of psychology as well. The remaining 'spatial' chapters discuss sheets and tubes, borders, binaries, centers, and layers; the 'temporal' subjects include calendars, arrows, breaks, and cycles.

In the chapter on borders, Volk discusses the ways scientists often impose them,

> *isolating parts of nature for study. Galileo framed Jupiter with a telescope to watch its moons as a system. ...Fusion physicists confine plasmas in magnetic bottles. ... I still recall the flash of delight I felt as a student during a lecture when I was struggling to learn the theoretical engineering tool called control volume analysis. [What moved me was] the insight that the technique consisted of little more than slapping imaginary conceptual borders around a system. ...*
>
> *Modellers... may lump all marine waters into a single bounded "box" – or three, five, seventeen, or even thousands – and then compute the crossing fluxes of these control volumes. Climate modellers cover the mathematical Earth with grids of such*

boxes. In the workings of science, barriers and pores, walls and bridges, are probably isomorphic to the synergy of spheres and tubes. (pp.65-66)

Volk's plenitude of examples of the borders metapattern, drawn equally from culture and science, offers the reader a different *sense* of the structure of nature. How might we apply this sense to the paradox of harmony? If we follow Will Wright in viewing our largest problems as basic pathologies of organization, it seems to me that one could perform a 'metapatterns' analysis of the relations between specific scientific enterprises and the world they influence. For example, perhaps creatively 'slapping conceptual borders' around areas of society and/or ecosystems at different scales, as in control volume analysis, could forewarn us of 'cross-border' problems.

Borders function as bulwarks against the forces of disruption. They cloak creatures and their internal parts against the ravages of the exterior world – the ionizing, lysing, dissolving, jolting, combusting, dispersing, bursting, rotting, eating, and crushing world. Borders hold at bay all that would destroy the difference between being and environment; they prevent universal homogenization.

Life's borders accomplish much of their bulwark functions with a simple and generic design. This design can be seen in cell membranes made of lipid molecules; in tree bark, with its tiny cellulose cages of dead cells; in mammal skins of keratinized, flattened, dead cells; also in animal hairs, scales, and feathers; in virus shells of identical protein subunits; in bird nests and beaver dams of twigs and sticks and mud. This generic design is even used for bounding the precious information contained in chromosomes, whose ends are buffered by very short sequences of DNA repeated thousands of times. (p.52)

Consider some examples of dissonance between science and social life mentioned in Wright's book: IUDs, mastectomies, silicone breast implants. Each seemed a triumph of technical reason, a harmonious bit of theory and engineering within its narrow conceptual borders, but loosed on women these technologies were often disasters. Did scientists lose sight of the different, more complex borders within living bodies? Was this to misunderstand the metapattern of borders? What about Botkin's case of the starving elephants in Tsavo? If the park's borders had been more porous, allowing the animals to come and go in search of food, the herd might have flourished. Instead scientific rigor was wasted crafting 'natural' policies within bounds too small for them to work. 'The pattern that connects,' as Bateson said, is the key to understanding links between human and environmental events. There might be as many applications of Volk's metapatterns to the paradox of harmony as there are individual scientists thinking about the role of their specific case studies, ethnographies, experiments, and theoretical voyages in the 'big picture' of biospheric health.

If Wright is correct to raise the ideal of 'wild knowledge,' measured analogically by the medicine/health divide, and if Botkin presents a masterful case of doing just that, Volk's work sets out a broad and creative perspective within which the wisdom of any particular scientific event might be assayed. Each of these books offers fresh ideas, not rigid prescriptions, and implies practical ways in which scientists might become more sensitive to the larger disharmonies that surround us all.

Luke Wallin is an Associate Professor of English at the University of Massachusetts, Dartmouth, and Senior Research Associate at the Center for Policy Analysis.

Reviews

Gordon Laird and Sue Zielinski (eds) Beyond the Car: Essays on the Auto Culture. Toronto: Steel Rail Publishing / Transportation Options, 1995

By John Sandlos

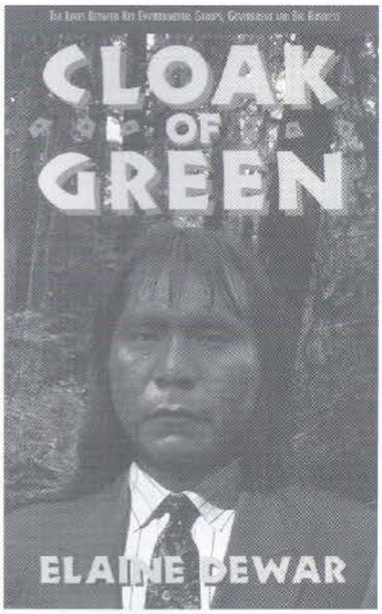
You're in the driver's seat. Put in the keys, start the engine and head out to the highway. Ease into the fast lane, pull down the top and let the wind flow through your hair. You're free. Or so the story goes. Soon you hit a traffic jam. The air becomes unbreathable. You shut out the wind, the sun and watch the world through your windshield as if it were on a television screen. You are stuck between two points on a map, out of place, out of time and out of luck. Ah, to be free in America.

Born out of the 1993 Second International Conference on Auto-Free Cites, Sue Zielinski and Gordon Laird's *Beyond the Car* examines the "freedom" of the auto culture in North America, and its continuing emergence as a global phenomenon. The various contributions trace the rise of the of the auto industry in North America, the subsequent industry inspired demise of public transportation in major urban areas, and more recent campaigns of resistance such as the spontaneous construction of traffic calming "woonerf," or living islands, in the streets of the Dutch community of Delft. In doing so, the book broadens the discussion of the automobile from a simple pollution reduction exercise to a more imaginative re-creation of life without the automobile. Appropriately, a diverse group of authors have contributed to this project (transportation activists, urban planners, green economists and local politicians), all of whom attempt to provide a loose blueprint for a less car dependant society. The broad visions that becomes clearer as on reads through the book is one that includes communities with green space rather than parking space, a bicycle revolution, clean and efficient public transportation, safe places to walk, ample space for children to play, and the return of street level interaction between neighbours. It is, as the editors suggest in the introduction, an "arrangement of options, possibilities and ideas, so that people can make their own decisions about the automobile."

As such, *Beyond the Car* succeeds on many different levels. Most importantly, the diverse essays in the volume remain focussed and complementary. Film criticism concerning car movies rests easily alongside urban planning literature, or thoughts on the global economy. While printing diverse essays in their casual conference form can be the weakness of many volumes, the warmth, humour and the depth of the contributions in *Beyond the Car* suggest that this is not the rule of thumb. Sean Hayes' hilarious "Auto-Biography: An Alternative History of the Car," and Eric Mann's personal account of his anti-pollution activism in Los Angeles are particularly interesting examples that affirm the value of this approach.

Most importantly, *Beyond the Car* succeeds by revealing the extent to which a technological tool can dominate the lives of its users. By choosing one form of technological freedom in the form of the automobile, we may have simply created a new box within which to live. In the closing essay, Zielinski describes an auto dominated future in which "smart" cars are guided in "packs" at predetermined times onto highways that would otherwise be permanently congested. As the complexity of the technology grows, so does its power to control our movements and our daily routines. We will have *become* the car rather than just simply users of the technology.

Beyond the Car artfully offers both simple and complex alternatives to the freeway Orwellianism that Zielinski describes. It is an essential user guide to life after the car and, as such, it is worth our thoughtful reflection and attention.



Elaine Dewar, Cloak of Green, Toronto: James Lorimer and Co., 1995

By John Sandlos

The latter days of the 1980s were heady ones for the environmental movement. Unprecedented levels of concern for the ecology of the earth was expressed through opinion polls, community projects, and financial support for environmental causes and organizations. Even national governments were adopting rhetoric that had been dismissed as radical "Green" sentiment only a few years previously. It seemed the "age of ecology" was reaching its zenith moment in the annals of world history.

Only a few years since that time, a worldwide economic recession, chronic high unemployment, and the ascendancy of deregulative neo-conservative ideology has forced green politics to return to its familiar marginal status.

In many ways, Elaine Dewar's *Cloak of Green* is a chronicle of the fall of the environmental movement from its prominent position on the public agenda. Starting the story at a "grassroots" 1988 meeting in a Toronto church featuring speeches by Kayapo leader Paulinho Paiakan, Dewar investigates the entire apparatus of NGOs, corporate donors and Native leaders surrounding the Amazon rainforest protection movement. Her exhaustive and meticulous research leads her into the "underworld" of environmental politics, a place where Governments covertly further their political aims as the sole funders of supposed Non-Governmental Organizations, environmentally challenged corporations (Brascan, DuPont) create "company unions" by providing large sums of money to environmental groups, and where "green" businesses (the Body Shoppe, Ben and Jerry's) channel money through research oriented NGOs to help set up extractive reserves that further their business interests in the Amazon.

Dewar's journalistic trail eventually leads to the 1992 Rio Summit, where environmental NGO's (she calls them Private Government Organizations) sit as delegates with business and government representatives. Unelected, unaccountable and aloof, these umbrella organizations are in what Dewar describes as "the loop," a loose coalition of interests bent on managing the environment and the economy on a global scale. At the centre of this "loop" is Maurice Strong, and what Dewar describes as his vision of "global governance." (Strong's Business Council on Sustainable Development was a key power broker in Rio, but was listed by Greenpeace as an anti-environmental organization). Dewar appropriately contextualizes the "loop" within the rising tide of free trade and, in a retrospectively funny passage, the emergence of a computer network called "the Internet." As Dewar's portrait of Rio shows, the environmental consciousness raising of the late 1980s has been dimmed by an effort sail on the perfect edge of sustainability (usually meaning sustainability somewhere else), using technology to manage the earth in a way that serves the voracious appetites of global capitalism.

Dewar's work provides a valuable insider's look at what Wolfgang Sachs has described as the new "ecocracy" of global environmental managers and bureaucrats. Her insightful interviews, her journalistic insights into key events, and her tenacious ability to penetrate the back rooms, parties and closed door meetings of various groups and conference delegates are the glue that binds her work together. Moving from meeting to meeting, and from personality to personality, Dewar never reveals too much at once, and her book holds the reader like a good mystery novel from beginning to end.

Nonetheless, despite the high quality journalism in the book, there are some theoretical weaknesses in its central arguments. First, Dewar suggests her prime concern for the Amazon relates to her children's health, and that this should be the prime consideration for environmental organizations. The argument implicitly lends credence to the global management ethos she wants to critique. The destruction of the Amazon is, presumably, permissable so long as it managed in a way that doesn't affect our children.

Second, Dewar questions the global implications of deforestation, playing the endless cat and mouse game that demands further scientific "proof" for planetary warming trends. Thus, rather than provide an alternative vision for global environmental management, she questions the need for it in the first place. Dewar clings hopefully to the nationalist status quo, suggesting that legal action by one country against another is by itself a sufficient deterrent to transboundary pollution. She ignores the failure of strong national governments to effectively manage the natural world, as well as the persistent efforts of governments to undermine local economic relations and subsistence livelihood in the name of the national economy. As such, economic nationalism can be seen merely as globalization in a microcosm, and not a viable alternative to it.

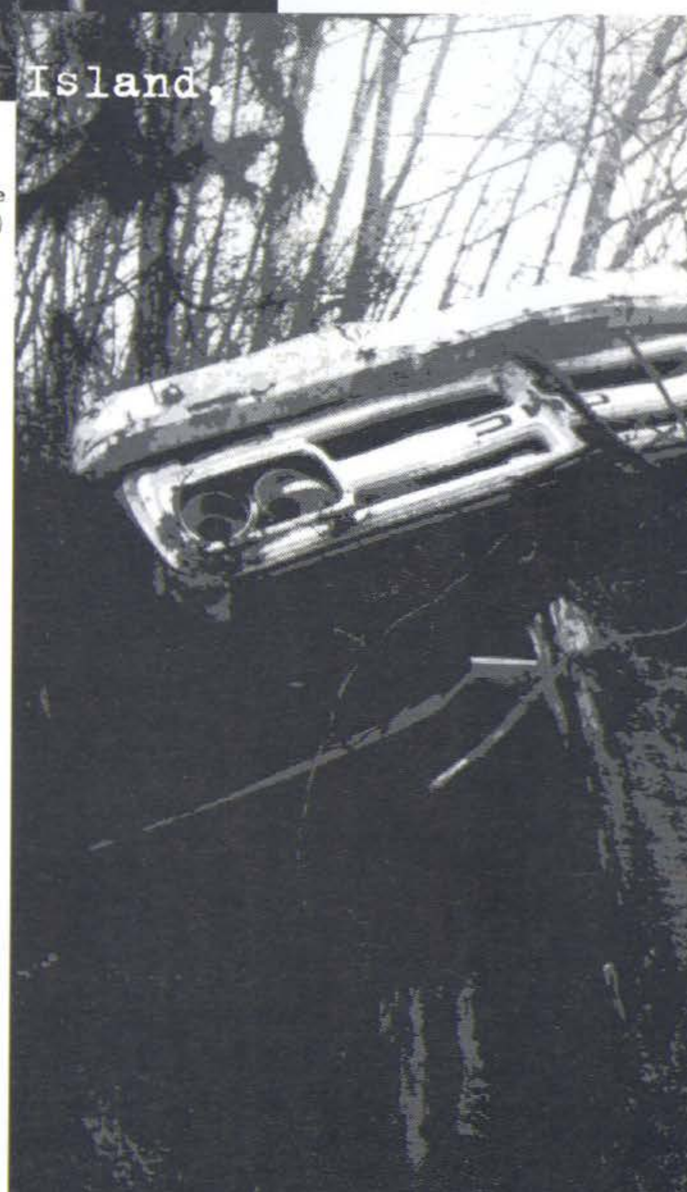
Lastly, by ignoring the grassroots and local activist voices of the environmental movement, Dewar paints a picture of the movement as monolithic and homogeneous, with everyone from David Suzuki to Elizabeth May inside a sinister conspiratorial "loop" of influence and power. A more balanced discussion of the dialogue between grassroots and mainstream environmental activists would have been of great benefit to the volume.

Nonetheless, kept in perspective, *Cloak of Green* is fascinating look at the consolidation and co-optation of various environmental "players" in the years leading up to the Rio summit. Though deserving of thoughtful consideration, it is Dewar's "cloak and dagger" storytelling abilities that make this book difficult to put down.

John Sandlos is currently pursuing a Master's Degree in Environmental Studies at York University, where he focuses on wilderness issues.

Techno-nature on Graham Island, Haida Gwaii

(or, the Death of Cars, cause they've gone as far as they could go)



I came to these islands at the edge of the world looking for nature, pure and pristine. Before me a century of settlers had come, bringing with them first plows (which they left and abandoned), then cars (which they left and abandoned). (Some of those cars still drive, but when word gets around that a police cruiser is visiting from the mainland, the more beat-up jalopies, unlicensed & uninsured, hide out until the roads are safe for them again.) I came armed with notebook, to do research. Instead I sunk into the moss, the dense, misty wetness of the earth. Like these cars, excess and refuse of industrial civilization, driven as far as they could go, then left stranded, refugees, on these islands, to be reclaimed by nature.

Adrian Ivakhiv is completing his Ph.D. at York's Faculty of Environmental Studies, writing about sacred places and the cultural and environmental politics of landscape. He also plays and composes music.

Guidelines for submissions: *UnderCurrents* aims to provide a forum for the presentation of interdisciplinary papers which might not otherwise have a venue for publication. This is not a mainstream or single discipline publication. We look for innovative critical discussions which challenge traditional conceptions of society and relationships between human and non-human nature, as well as the traditional boundaries of academic discussion. We recognize that the exploration of problems and questions regarding the relationships between nature, society, and self may draw from a variety of disciplines, and we encourage submissions from any field.

- Papers/Articles should be 3000-4000 words in length, double-spaced typed. Reviews can be either short critiques (500-1250 words) or full-length review essays. Do not send originals as they will not be returned. All submissions should be well researched and properly supported with documentation. Notification should appear as endnotes, and be kept to a minimum. Citations, references, and all other aspects of the submission should conform to the Modern Language Association Style Manual (1985).
- Poetry, photographs, and artwork, please include the title, medium, and date of the work. Although we cannot be held responsible for original artwork, all works will be handled with the utmost care.
- Include a name, address, and phone number with 2-3 lines of biographical information.
- *UnderCurrents* has an editorial policy which encourages authors to explicitly avoid the use of discriminatory discourse (eg: sexist, racist, etc.).

Please note: each issue is organized around a particular theme. Contact *UnderCurrents* for specific issue information.

Send submissions to: *UnderCurrents*, Faculty of Environmental Studies, York University
4700 Keele St., North York, Ontario M3J 1P3 (Canada)
Phone: 416-736-5252; Fax: 416-736-5679; Internet: ES_Under@orion.yorku.ca